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**FOREIGN
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JPRS Report

Science & Technology

***USSR: Electronics &
Electrical Engineering***

23 FEBRUARY 1988

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SCIENCE & TECHNOLOGY

USSR: ELECTRONICS & ELECTRICAL ENGINEERING

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ACOUSTICS SPEECH AND SIGNAL PROCESSING

UDC 621.396.96'08:621.391.82

ANALYSIS OF ACQUISITION AND TRACKING METERS FOR MULTISTEP ACQUISITION AND MONITORING PROCEDURES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 10 Dec 83) pp 1749-1756

[Article by V. M. Kamikov]

[Abstract] Radioelectronic instrumentation systems comprised of signal acquisition circuitry, a tracking meter and a detector can be simulated with mathematical models used for solving problems of parametric optimization of such systems. This paper extends the applicability of such models by including a class of acquisition and tracking meters in which the decision making concerning the presence or absence of a signal in the search and/or tracking mode is accompanied by signal storage over several observation steps. The search and tracking procedures are thus multistep processes. This paper finds analytical expressions defining the continuity and reliability of the measuring process in these meters, taking into account the duration of the signal search and measurement reliability testing procedures. The analysis of such meters reduces to the construction of equivalent, combined single-step models. Though no sample calculations or design examples are cited in this purely theoretical treatment, it is noted that experimental data from an on-board microprocessor controlled range radar for approach navigation confirm the adequacy of the proposed model. References 6: 5 Russian, 1 Western (in Russian translation).

8225/5915
CSO: 1860/41

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NONPARAMETRIC DETECTION OF SIGNALS USING RANDOMIZATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 1 Feb 85) pp 1813-1817

[Article by A. N. Dmitriyenko]

[Abstract] Nonparametric detection of a signal against an interference background having unknown statistical properties is possible using randomization in the case of an amplitude quantized sample. This paper extends the results of the amplitude quantized case to the case of a continuous (unquantized) sample. The decision rules for signal detection are found in the class of randomized rules, when the decision that a signal is present based on each input sample is made using the result of selecting a random quantity having a specified distribution (written in terms of the probability that the detected signal decision is made for the given input using delta functions). Estimates of the decision rule efficiencies for the case of dependent and independent samples (derived as a function of the threshold signal losses as compared to optimal detection against an interference background having a known distribution density) show that a lack of apriori knowledge of the interference distribution density can lead to considerable threshold signal losses using nonparametric detection techniques, but parametric methods do provide a constant false alarm probability under these conditions. It is thus important to have apriori data on the statistical parameters of the received signals and make the most effective use of it. Tables 1; references: 4 Russian.

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ACCURACY OF DETERMINATION OF COORDINATES OF AN INDIVIDUAL RESOLUTION ELEMENT OF THE RADIO IMAGE OF TARGET WITH LOW NOISE LEVEL

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 5 May 86) pp 39-41

[Article by N. A. Potapov]

[Abstract] A comparative analysis is made of the accuracy of determining the coordinates of the individual elements of a radio image with a varying number of nonresolved shining points. The upper and lower limits are determined for the mean square deviation error of determining the coordinates of the individual elements of the images with an arbitrary number of nonresolved shining points. The author thanks D. V. Ponomarev for assistance in conducting statistical modeling on a computer. Figures 2; references: 2 Russian.

6415/5915
CSO: 1860/80

UDC 621.396.962.25

EFFECT OF MUTUAL RADIOINTERFERENCE ON CONTINUOUS RADIATION RADAR STATION

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 11 May 86) pp 51-54

[Article by S. S. Romanov and A. M. Chernyy]

[Abstract] The effect is investigated of radio interference, produced by a continuous radiation radar station with frequency modulation sounding signal on the receiving channel of a radar of the same type. An analytical expression is obtained for the magnitude of the measurement errors with respect to the distance and the radial speed of the target, with various versions of the frequency separation of the interacting radar stations. Figures 2; references 2: 1 Russian, 1 Western (in Russian translation).

6415/5915
CSO: 1860/80

UDC 621.391.14

EVALUATION OF EFFICIENCY OF SIGNAL CLASSIFICATIONS BY A RECOGNITION DEVICE

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 26 May 86) pp 60-62

[Article by V. L. Gutkin]

[Abstract] Relations are obtained which make it possible to determine the efficiency of signal classification by a recognition device entering into a control system, when the quality of operation of the latter is described by the probability of achievement of the required control result. References: 3 Russian.

6415/5915
CSO: 1860/80

UDC 621.396.946

MULTISTAGE MULTICYCLE SEARCH PROCEDURE FOR A COMPOUND SIGNAL WITH TWO THRESHOLDS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 26 Feb 86) pp 69-73

[Article by V. M. Sovetov]

[Abstract] A multistage multicycle search procedure (MMSP) for a compound signal with two thresholds is one of the procedures for detection of a signal with a nonfixed analysis time. In two previous articles by the author (in 1983) and one by S. S. Sviridenko (1974) investigations were made of MMSP with one threshold of each stage: expressions were found for the average time and the time of search dispersion, and optimization of the parameters of the search procedure was accomplished. In the present article an expression is obtained for the average MMSP with two thresholds at each stage, and the parameters of the search procedure are optimized. Figures 4; references: 6 Russian.

6415/5915
CSO: 1860/80

UDC 621.391.2:691.396

HOMOMORPHIC FILTRATION FOR DISCRIMINATION OF RADIO NAVIGATION SIGNALS AND REREFLECTIONS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 30 May 86) pp 83-85

[Article by Ye. A. Arkhipov and A. K. Bernyukov]

[Abstract] The outlook for use of homomorphic filtration of the signals of a microwave system for landing aircraft, affected by nonstationary intrabeam noise from local objects in airports, has been described in previous articles by the authors. The output signal of a homomorphic kepstral filter with the specific conditions considered in the present article is close to the response of the inverse filter of G. Urkovit described in a 1954 paper which provides ideal signal discrimination in a multibeam channel. Figures 2; references 7: 6 Russian, 1 Western (in Russian translation).

6415/5915
CSO: 1860/80

UDC 534.231.1

MODE BEHAVIOR IN WATER WAVEGUIDE FOR VARIOUS DEPTH DISTRIBUTIONS OF SOUND
VELOCITY IN WATER (NUMERICAL ANALYSIS)

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 27 Nov 85) pp 577-584

[Article by N. S. Ageyeva and V. D. Krupin, Acoustics Institute imeni N. N.
Andreyev, USSR Academy of Sciences]

[Abstract] In a shallow sea at depths of more than 200 m, when the influence of the bottom cannot be disregarded, seasonal variations in the hydrological conditions can result in considerable changes in the sound velocity distribution over the depth $[c(z)]$. This paper numerically analyzes the group velocities, attenuations and amplitudes of individual modes as a function of frequency (between 0 and 300 Hz) with variations in the $c(z)$ profile. The role of this profile in the formation of the modal structure of the sound field is found through a comparison of the characteristics of the classical waveguide modes with the isovelocity profile ($c(z) = \text{const.}$) as well as for waveguides with four difference $c(z)$ profiles. Depending on the particular profile, the mode behaviors differ sharply, even with the simplest model of the bottom as a fluid--uniform half-space separation boundary. These results are useful primarily for better understanding the physical picture of sound field formation with such seasonal variations and for time-domain analysis of the field when interpreting experimental data or establishing underwater signal processing criteria. Figures 5; references: 6 Russian.

8225/5915
CSO: 1860/40

ENERGY AND CORRELATION PARAMETERS OF LOW FREQUENCY ACOUSTIC WAVES IN
UNDERWATER SOUND CHANNELS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 16 Sep 85) pp 591-597

[Article by V. V. Artelnyy, V. D. Kukushkin and M. A. Rayevskiy, Institute of
Applied Physics, USSR Academy of Sciences]

[Abstract] Since geometric acoustics are frequently not applicable to sound wave propagation analysis at frequencies of 10 to 100 Hz in underwater channels and modal analysis requires cumbersome equations, this paper derives comparatively simple equations for the correlation function and spectra of the normal modes that can be used to calculate the energy and correlation parameters of sound waves scattered by sound velocity inhomogeneities: the attenuation of the coherent component, transformation of the angular and modal spectra of tonal signals due to random internal rays and the sound scattering by the fine structure. While earlier literature assumed exponential profiles for the index of refraction, these formulas apply to any underwater sound conducting structures. The loss decrement found to be only slightly dependent on the frequency at 10 Hz and higher. The values of the decrement agree with experimental data at 10 to 100 Hz and above 500 Hz, relaxation losses predominate. Figures 1; references 13: 9 Russian, 4 Western (1 in Russian translation).

8225/5915
CSO: 1860/40

ROLE OF THREE-DIMENSIONAL INHOMOGENEITIES IN OCEAN FLOOR IN SOUND SCATTERING
BY DEEP OCEAN BOTTOM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 27 Jan 86) pp 697-699

[Article by Yu. P. Lysanov, Acoustics Institute imeni N. N. Andreyev, USSR
Academy of Sciences]

[Abstract] The model of the ocean floor as a statistically uneven dual scale water-ground separation boundary used in the analysis of sound backscattering by a deep ocean floor is not truly applicable to abyssal plains. A more realistic model is an absorbing layer of sediment containing random, three-dimensional irregularities. When the backscatter ratio for the ocean floor in this case is plotted as a function of frequency (between 0.1 and 10 kHz), the nature of the curves (having a single minimum) indicates the existence of at least two types of inhomogeneities: one resulting in the decline of the

backscatter ratio at frequencies below 1-2 kHz and the other causing the ratio to increase at frequencies above this range. This paper develops a simple analytical expression describing this backscatter ratio behavior that better fits the experimental data than the earlier model. Figures 1; references: 3 Russian.

8225/5915
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UDC 534.23

FAST ALGORITHM FOR COMPUTING SOUND FIELD IN STRATIFIED OCEAN BY MEANS OF NORMAL MODE ANALYSIS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 22 Jan 86) pp 703-705

[Article by A. M. Plotkin, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] The sound pressure field produced by a monochromatic source in a layered ocean of constant depth is found by solving the boundary-value problem of the Helmholtz equation. The most widespread approach to this solution is the normal mode expansion of the field, which consists in closing the integration boundary at infinity and computing the resulting integral by means of residues. This paper describes a fast, efficient algorithm for this. The propagation medium is approximated as a stratified ocean and a layered fluid bottom, with a linear function assumed in each water layer for the square of the index of refraction. Simple analytical expressions are found for the algorithm error and computing time as a function of the number of channel modes and bottom modes. Horizontal sections through a sound field are computed for the deep ocean at 50 Hz in the case of 58 channel modes, 113 bottom modes and 420 points along the path and graphed out to a range of 80 km. The attenuation over this range varies between about -15 and -45 dB. The algorithm is 60 times faster than previous procedures. Figures 1; references 6: 4 Russian, 2 Western.

8225/5915
CSO: 1860/40

ESTIMATION OF NORMAL MODE ATTENUATION DUE TO ABSORPTION IN BOTTOM

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 4 Mar 86) pp 705-708

[Article by Ye. A. Rivelis and S. Yu. Slavyanov]

[Abstract] A previous analysis of normal mode attenuation in depth-stratified water layer by V. D. Krupin showed that the attenuation factor may be a non-monotonic function of the mode number when it initially falls off with respect to the number and then increases. This effect can occur with an increase in the cycle length normal mode number of the corresponding ray. This paper reduces Krupin's formulas to engineering expressions and discusses examples of sound velocity profiles for which the anomalously small attenuation can be characteristic of one individual normal mode having a number other than unity. It is assumed that the velocity profile over the depth is such that normal modes are reflected from the bottom (there is no sound channel). The simple engineering formulas for normal modes with low numbers are obtained via the Pekeris model. A sample calculation of the first four normal modes at a frequency of 66 Hz in 400 m of water is adduced: the lowest attenuation is characteristic of the first normal mode, then the third and only after them comes the second, fourth, etc. References 8: 3 Russian, 5 Western.

8225/5915
CSO: 1860/40

ANTENNAS AND PROPAGATION

UDC 621.396.677.519.6

ADAPTATION OF ANTENNA ARRAY UNDER NONSTATIONARY CONDITIONS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 20 May 86) pp 8-12

[Article by I. N. Presnyakov, O. G. Rudenko, and O. V. Sytnik]

[Abstract] The article investigates a recurrent algorithm for processing of signals in adaptive antenna arrays, which provides, in the case of signal-to-noise ratios up to 2.0 dB, a gain in the speed of response by a factor of 1.5-2 as compared with the widely used Widrow gradient minimization without a significant increase of equipment expenditures. The results of computer modeling of the receiving antennas and signal sources are described.
References: 2 Russian.

6415/5915
CSO: 1860/80

UDC 621.396.1

COMPARATIVE ANALYSIS OF OPERATION OF AUTODYNE AND HETERODYNE DEVICES FOR SHORT-RANGE RADAR SYSTEMS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received 7 Apr 86) pp 57-58

[Article by A. F. Tereshchenko]

[Abstract] An analysis in terms of radiation power, minimum reception power and signal/noise ratio which determine range based on a comparison of power potentials as a general criterion is made of systems of short-range radar using autodyne and heterodyne methods of operation. Criteria are obtained for evaluation of autodyne and heterodyne devices. With respect to power potential, the autodyne method is not inferior to the heterodyne and in view of the small size of the equipment and the simplicity of its performance is considered preferable. References: 5 Russian.

6415/5915
CSO: 1860/80

BROADCASTING, CONSUMER ELECTRONICS

UDC 621.397.6

CONCERNING PROSPECTS FOR DEVELOPMENT OF SUPER-HIGH DEFINITION TELEVISION SYSTEMS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 16 Apr 86) pp 3-7

[Article by S. V. Novakovskiy]

[Abstract] The following items concerned with the prospects for developing television systems with increased or super-high definition (TSISD) are considered in some detail: 1) Choice of number of lines; (2) Format of frame; 3) Frequency of frames; 4) Method of raster scan; 5) Transmission of color signals; 6) Compatibility of new system with old; 7) Signal-noise in new TSISD system; 8) Receiving screen for TSISD system; and 9) Distribution of TSISD signals with respect to territory of country. References 14: 12 Russian, 2 Western.

6415/5915
CSO: 1860/80

UDC 621.396.97:621.38

DIGITAL CONVERTER OF SOUND SIGNALS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 11 May 86) pp 41-43

[Article by A. N. Ignatov, D. A. Krivozyatev and K. V. Martyukhin]

[Abstract] The structure and design are considered of a digital converter of sound signals, based on integrated circuits with an average degree of integration. The converter satisfied requirements imposed on channels for forming first-class radio broadcasting programs. The digital converter developed is also recommended for use as a basic unit of a digital tape recorder. It can be used for introduction of analog information into a computer and subsequent output of digital information from the computer with representation of the result in an analog form. Figures 2; references: 4 Russian.

6415/5915
CSO: 1860/80

CIRCUITS AND SYSTEMS

UDC 621.34:621.376.4

ELECTRONIC PHASE MODULATORS FOR ANALOG-TO-DIGITAL CONVERTER

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 12 May 86) pp 54-56

[Article by A. F. Miheyev and V. Androsenko]

[Abstract] The use of phase modulation in analog-to-digital converters makes it possible to increase the stability and the interference freedom of their operational amplifier. The present article considers new circuit solutions for phase modulators developed by the authors and a comparison of characteristics is made. An overall characteristic of the modulators is the existence in each of them of a 4-element Γ -shaped phasing circuit and a Kirchoff adder (primarily by means of an operational amplifier). Figures 5; references: 4 Russian.

6415/5915
CSO: 1860/80

UDC 621.395.4:621.376.56

EQUIPMENT FOR NEW GENERATION OF PRIMARY DIGITAL TRANSMISSION SYSTEM FOR URBAN TELEPHONE NETWORKS IKM-30-4

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 10 Jun 86)
pp 1-4

[Article by A. Ye. Botvinik, S. A. Davydov, N. A. Kotelnikov and B. I. Shlyuger]

[Abstract] For a long time the primary IKM-30 digital transmission system was a basic system used on urban telephone networks for organization of inter-exchange trunks. Developed in the middle seventies, this equipment does not satisfy today's requirements with respect to reliability, and a number of its characteristics do not satisfy the recommendations of the Consultative Committee for Telephone and Telegraph (CCITT). Automation of the operation of the equipment is impossible. Additional requirements on the transmission system depend upon the introduction of electronic switching systems into urban telephone networks, interaction of which with the electromechanisms of the automatic telephone stations is accomplished with the aid of a primary digital transmission system. The equipment of the new fourth generation IKM-30-4, the series production of which has been started by industry, as compared with the IKM-30 digital transmission system, assures a more flexible network structure characterized by lower power consumption and increased reliability. It makes possible organization of inter-exchange trunks between automatic telephone stations of any system, and with the use of additional equipment--subscriber's lines and channels for transmission of discrete information. Automatization of its servicing is incorporated into the equipment. With the assistance of individual equipment units it is possible to create primary digital linear channels and the channel generating equipment of digital transmission systems of a higher order. The parameters of the equipment meet the latest recommendations of the CCITT. This article is the first of two papers.

6415/5915
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UDC 621.395.4:621.376.56

LINEAR PATH OF PRIMARY DIGITAL TRANSMISSION SYSTEM IKM-30-4

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 23 May 86)
pp 4-9

[Article by D. A. Poberezin and S. I. Rabinovich]

[Abstract] The linear path of the IKM-30-4 digital transmission system constitutes a self-contained part of the equipment and along with the basic purpose--transmission of a composite signal from the terminal of analog-digital equipment--can be used independently for relaying digital information with a speed of 2048 kilobit/sec. The linear path contains these devices: regeneration of digital signal, remote power supply, remote checking link between operators, lead-in of linear cable, protection from unsafe effects caused by lightning discharges and electrical transmission lines. Pairs of low-frequency cables of the urban telephone networks are used as a transmission means. Problems encountered in the development of the linear path of the IKM-30-4 are listed. Figures 9; references: 5 Russian.

6415/5915
CSO: 1860/84

UDC 621.395.341

PROBLEM OF SETTING UP NORMS FOR QUALITY OF CALL SERVICING IN TELEPHONE NETWORKS: REVIEW

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 3 Oct 85)
pp 12-16

[Article by V. A. Sokolova]

[Abstract] Basic concepts in the literature (almost all Western), connected with normalizing the quality of servicing (QOS) calls in telephone networks, are considered. These include: 1) Two principles for normalizing QOS; 2) Cumulative characteristics of QOS; 3) Integral indices of QOS; and 4) Normalization of QOS with allowance made for existing telephone load. Figures 2; references 29: 4 Russian, 25 Western.

6415/5915
CSO: 1860/84

UDC 621.394.1

EQUIPMENT FOR DOCUMENTARY COMMUNICATION AT COMMUNICATION-86
INTERNATIONAL EXHIBITION

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 pp 17-18

[Article by V. A. Boyar, Yu. B. Surnin and G. F. Balkin]

[Abstract] Switching telegraph equipment shown at the exhibition is described by V. A. Boyar. Equipment which can only conduct switching in telegraph networks and networks for transmitting data included the USSR ATGK-1 automatic telegraphic commutator. It can serve as the basis for the construction of telegraph stations and substations. The ATGK-1 is a completely electronic piece of equipment with decentralized control based on microprocessors. Terminal devices (TD) shown at the exhibition are described by Yu. B. Surnin. Some technical characteristics of these TD are given in a table. Facsimile techniques presented at the exhibition are described by G. F. Balkin. No figures or references.

6415/5915
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UDC 621.396.4

EQUIPMENT FOR LINE OF SIGHT RADIO RELAY COMMUNICATION SYSTEMS

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 10 Sep 86)
pp 19-25

[Article by Yu. T. Marimont]

[Abstract] Equipment for radio relay communications systems shown at the Communication-86 exhibition and produced by foreign firms are described in detail. The principal technical parameters of a number of transceivers produced abroad are shown in a table. The activities of the French firm Alcatel are considered in particular. Figures 4; references 16: 1 Russian, 15 Western.

6415/5915
CSO: 1860/84

UDC 621.396.931

MODERN CONDITION AND PROSPECTS FOR DEVELOPMENT OF MOBILE TELECOMMUNICATION SYSTEMS

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 27 Aug 86)
pp 26-33

[Article by L. Ye. Varakin, O. L. Pukyanova, and V. N. Trubin]

[Abstract] The following items shown at the Communication-86 international exhibition are described: 1) Cellular systems of mobile and stationary communication; 2) Commercial radiocommunications by mobile means; and 3) Systems for personal radio calls. A survey is made which shows that systems of mobile communication are actively incorporated into the various spheres of activity of human beings. At the same time it is necessary to expect that on the basis of cellular systems, including the use of satellite communication, new systems of general application will be used for production of communication and personnel signaling. The growth trend for mobile communication systems is directed towards the creation of systems for mass radiotelephone communication with a high quality of servicing and transmission of information. Figures 8; references 7: 2 Russian, 5 Western.

6415/5915
CSO: 1860/84

UDC 621.396.67

KPZV SWITCHBOARD FOR SOUND BROADCASTING PROGRAMS

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 4 Dec 85)
pp 40-42

[Article by I. M. Krol]

[Abstract] The KPZV switchboard for sound broadcasting programs developed by the Central Design Bureau of the USSR Ministry of Communications is intended for use in the switchgear equipment of radio broadcasting and for use in switching of the low-frequency equipment of radio transmitting centers. The object of developing the device is the creation of general purpose switching equipment for the primary distribution channels of broadcasting programs, assuring high reliability and efficiency of switching and transmission of programs with qualitative indices, conforming to a high class. The switchboard was developed to replace the SVKS-2 equipment produced at present. The principal advantages of the KPZV are: reduction of time expended on switching because of preliminary preparation of connections; automatic control of switching making it possible to reduce the number of personnel, as well as automatic inspection of connections, decreasing the time for detection of failures. The computed yearly economic effect is 1.4 million rubles. Figures 4.

6415/5915
CSO: 1860/84

UDC 621.396.677.83

BROADBAND NONAXIOSYMMETRICAL ANTENNA WITH 1.15 METER APERTURE DIAMETER

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 27 Jan 86)
pp 43-46

[Article by A. A. Timofeyeva, I. A. Kozlovskaya, T. A. Kazakova, and
Z. K. Khlopkova]

[Abstract] Together with the axiosymmetrical type, the high-grade nonaxiosymmetrical antennas RPA-2P-2 and ANK-1,1 are used on Soviet direct visibility radio relay lines. The horn-parabolic antenna (RPA-2P-2) has very large dimensions and mass, which in some instances preclude the possibility of its use. The ANK-1,1 is smaller but the outlet of the exciter is directed at an angle of 22° to the vertical which hinders its connection with a vertical waveguide transmission line. In addition, its use is restricted by a small amplification factor. Industry has mastered production of one more non-axiosymmetrical antenna, the ANK-1.5 which with respect to basic indices can also be assigned to the class of high-grade antennas. The construction, basic geometrical dimensions, and the electrical parameters of the ANK-1.5 and its variations are described. These antennas can be used in the most different communication systems operating in the frequency range of 3.2 - 13.25 GHz. Figures 7; references: 5 Russian.

6415/5915
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UDC 621.396.677.49

FORMING OF LOW-DIRECTIONAL PARTIAL DIAGRAMS OF MULTIMODE ANTENNA

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 26 Feb 86),
pp 46-49

[Article by Yu. N. Nosov]

[Abstract] The antenna arrays of radiators, low-directional in the horizontal plane, and arranged around a high-altitude support, are widely used at transmitting centers for television broadcasting and in communication systems with mobile objects. An increase of the number of individual radio devices connected to one antenna and the minimization of the number of radiators for a given radius of the support without worsening the uniformity of the antenna diagrams in the horizontal plane are of current interest. The present article solves the problem of forming low-directional partial diagrams of a multimode antenna with the smallest possible number of radiators of the array, and the conditions are determined for which connection is possible of different numbers of independent channels. Figures 6; references: 3 Russian.

6415/5915
CSO: 1860/84

PRINCIPAL RESULTS OF DEVELOPMENT AND RESEARCH OF GEZAKON MULTIPLE CONNECTORS

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 26 Nov 85)
pp 50-53

[Article by V. A. Drachev, I. G. Perekhodnik and I. A. Litovki]

[Abstract] Industrial production and introduction of domestic quasielectronic automatic telephone systems (ATSKE) into the Soviet Union's communication networks has shown that they can be improved by the development of elements characterized by improved parameters, by smaller expenditures of labor and materials, as well as improved principles of control. Among such devices a distinctive place is occupied by multiple connections (MC) used for constructing ATSKE. Fereed MC (gerkons--a sealed-contact reed relay--based on ferrites) are utilized today in ATSKE, but work is being conducted at the Leningrad Branch of the Scientific Research Institute of Communications with respect to the creation of gezakon MC, the construction and technology of which are simpler. Gezakons are potted magnetically controlled memory contacts. A gezakon does not differ from a gerkon with respect to its exterior form and dimensions. However, it possesses an internal magnetic memory which makes it possible to create switching devices on its base which are simple with respect to construction and technology. In gezakon MC the magnetic system of the switching points does not contain variable magnets and flux supplies. The volume of these MC is two times smaller than the volume of fereeds, which makes it possible in the body of the fereed MC with $8 \times 8 \times 8$ or $8 \times 8 \times 4$ switching parameters to arrange two similar gezakons for MC. During development of four-wire gazakon MC, complex problems of a design and technological nature were resolved including: security of necessary magnetic flux through closed gezakons at switching points and elimination of mutual magnetic effect between control circuits of switching points. The article considers the following items in some detail: 1) Magnetic system of switching points of gezakon MC; 2) Features of the magnetic system of switching points of four-wire gezakon MC; and 3) Features of construction of four-wire gezakon MC. Figures 8; references: 7 Russian, 1 Western.

6415/5915
CSO: 1860/84

UDC 621.398.088.8

MULTIDIMENSIONAL PULSE DISTRIBUTOR

Moscow ELEKTROSVYAZ in Russian No 12, Dec 86 (manuscript received 16 May 84)
pp 54-56

[Article by L. I. Kogay]

[Abstract] Known linear pulse distributors have a significant deficiency--the number of its output circuits is equal to the number of elementary cells, with the aid of which the output pulse is formed and all the circuits have a single pulse repetition frequency. The present article demonstrates the possibility of constructing a multidimensional pulse distributor of large capacity but small total length with different pulse repetition frequencies.

References: 5 Russian.

6415/5915
CSO: 1860/84

UDC 621.396

EXPERIMENTAL INVESTIGATION OF EFFICIENCY OF SYSTEM OF ZONE SHORT-WAVE RADIO COMMUNICATION WITH REMOTE REPEATER

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 15 May 86) pp 13-17

[Article by O. V. Golovin]

[Abstract] The results are presented of an experimental investigation of a zone system of short-wave radio communication with a remote repeater (RP) which makes it possible to substantiate the advantages of a communication system with a RP over a system with direct communications. Recommendations are made with respect to construction of pickups for evaluation of the quality of adaptive communication channels. During the investigation an automated system for assembly and processing of data, developed in 1983 at the Moscow Electrotechnical Institute of Communications (MEIS) on the base of a micro-computer, was used. Figures 3; references: 7 Russian.

6415/5915
CSO: 1860/80

UDC 621.374.33(088.8)

DIGITAL DISCRIMINATOR OF MULTIPLE FREQUENCIES

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 24 Mar 86) pp 30-34

[Article by V. F. Odinokov]

[Abstract] A digital frequency discriminator based on an analysis of the relative position of input signals is described with the help of a block diagram. An algorithm of operation and an expression for a discriminatory characteristic are presented. Figures 3; references: 2 Russian.

6415/5915
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UDC 621.317.382.016.24:681.335.5

METHOD OF DIGITAL MEASUREMENT OF THE POWER OF NOISY SIGNALS WITH NONLINEAR ANALOG-TO-DIGITAL CONVERSION

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 10 Mar 86) pp 34-36

[Article by S. A. Plakhotnyuk and E. A. Khenkin]

[Abstract] The use of analog-to-digital converters with a nonlinear (quadratic) quantization characteristic is proposed for measuring the power of low-frequency noisy signals. Errors of measurement were calculated, and the results of calculation were confirmed by modeling on a computer. Development of the software of a digital measurer of the noise factor of transistors showed that use of the proposed method of measuring the speed of response of the KR580IK80A microprocessor is satisfactory for servicing eight measurement channels indicating the high efficiency of the proposed method. Figures 4; references: 2 Russian.

6415/5915
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UDC 681.7.068

VOLSTRONS FOR COMMUNICATION LINES OF COMPUTERS

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 30 May 86) pp 92-93

[Article by Yu. R. Nosov, V. N. Fayzulayev, V. A. Pavlychev and V. A. Gorin]

[Abstract] The structure, construction, and organization of communication lines between high-performance computers must meet the strict requirements of noiseproof devices. Consequently, in recent times computer developers have given considerable attention to the question of using fiber-optic communication lines, the advantage of which as compared with traditional communication lines for computers becomes increasingly obvious. The present article describes a method for construction of fiber-optical communication lines based on volstrons which are fiberoptic interface modules consisting of transmitting and receiving units, nondetachably connected to a short length of optical cable. (A photograph of it is shown) However, problems arise if these modules are used for lines longer than 100 m although it is possible to make adjustment allowing transmission over short distances (up to 1 km) for example in local networks. Figures 2; references 3: 2 Russian, 1 Western (in Russian translation).

6415/5915
CSO: 1860/93

UDC 537.523.4:536.421.1.001.24

MELT-THROUGH CHARACTERISTICS OF WALLS OF METAL OBJECTS STRUCK BY LIGHTNING

Moscow ELEKTRICHESTVO in Russian No 11, Nov 86 (manuscript received 26 Jun 86)
pp 22-27

[Article by N. R. Abramov, I. P. Kuzhekin and V. P. Larionov, Moscow Power
Engineering Institute]

[Abstract] Existing methods of determining the melt-through parameters of metal walls are based on rough approximations that produce considerable divergence from experimental data. This paper provides a more rigorous formulation of the problem of thermal melt-through, taking the size of the heat source into account as well as the level of thermal flux acting on different structural materials. Analytical expressions are derived for the thermal flux density distribution in the metal and then used to plot the variation in the melt-through depth as a function of time (from 5 to 40 msec) for various values of the heat conductivity, specific heat, material density and delivered heat flux density (the melt-through depth ranges from 0 to 2.0 mm). Expressions are also found for the melt-through resistant thickness of a thin plate, taking phase changes into account. Data from experimental checks using D16T alloy 1 mm thick exposed to 100 A for from 10 to 100 msec and aluminum anode plate 2 mm thick (the melt-through time is plotted in msec as a function of the current between 100 and 500 A) show good agreement with the proposed theoretical expressions. These analytical equations can be used to calculate the melt-through parameters of plates of various structural materials when struck by lightning. The assumption of a uniform heat flux density distribution and the use of the thermal response parameters of aluminum alloys do not introduce any significant errors into such calculations. Fusion and vaporization energies can be disregarded in the latter case for aluminum alloys. The choice of required wall thickness must be based on the maximum current, and not just the leak-through charge as recommended in earlier literature. Figures 6; references 18: 14 Russian, 4 Western (1 in Russian translation).

8225/5915
CSO: 1860/78

DETERMINATION OF INTENSITY OF THUNDERSTORM ACTIVITY USING RADIOPHOTONIC EQUIPMENT

Moscow ELEKTRICHESTVO in Russian No 11, Nov 86 (manuscript received 10 Mar 86)
pp 60-62

[Article by A. Kh. Adzhiyev]

[Abstract] A simple relation between the number of lightning strikes to ground, N , and the duration of thunderstorm activity, T (in days per year), is used for designing the lightning safety systems for power lines and other facilities in the USSR in areas with moderate thunderstorm activity: $N = 0.1T$. Radar measurements in the Northern Caucasus show a 15 to 20% deviation from this relation and a more precise determination of the correlation between N and T is made by using data from the same region obtained with the following system: A cm-band MRL2 radar and an automatic thunderstorm DF and range finder that analyzed the vertical electric and horizontal magnetic components of the emissions from lightning discharges, as well as meter and decimeter band radars for recording returns from ionized lightning strike paths. This equipment determined the duration of storms, the time of the first discharge in a cloud, the number of discharges per unit time in a cloud, the time of the first strike to ground, the specific density of the ground discharges during the storm, the frequency and time parameters of the electromagnetic radiation from the clouds and the relationship between ground thunderstorm discharges and discharges of all types. The annual specific discharges to ground is found to be $N = 0.005Tt_{avg}^{1.2}$, where t_{avg} is the average annual duration of a single thunderstorm in hours. Figures 1; references 9: 7 Russian, 2 Western.

8225/5915
CSO: 1860/78

UDC 621.382.323.029.64

PHYSICAL ASPECTS OF MICROWAVE FIELD-EFFECT TRANSISTORS (REVIEW)

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 5 Oct 83, after revision 8 Oct 85) pp 1681-1708

[Article by N. Z. Shvarts and V. G. Yelenskiy]

[Abstract] This comprehensive review of microwave MESFETs relies heavily on Western literature in surveying the state of the art and the constraints imposed by the device physics as illuminated by equivalent circuit models. The discussion of the general relations describing the operational mechanism of MESFETs is followed by the relevant equations and analytical models for devices with 1 micrometer gates as well as details of the smooth approximation theory. Since the latter models ignore certain physical phenomena (e.g. carrier diffusion from the channel into the Gunn domain and transversely), a two-dimensional analysis is described that takes the diffusion and strong field domain into account. Considerable space is devoted to the analysis of the saturation current and spurious currents as well as noise and stability limits. The best low noise microwave transistor noted is the unpackaged NE673 with a noise figure of 0.4 dB ($T_{eff} = 30$ K) at 4 GHz with a gain of 14.5 dB and 3.5 dB ($T_{eff} = 375$ K) with a gain of 6 dB at 26 GHz. Recent designs with 0.3 and 0.25 micrometer gates are also noted, having minimal noise figures of 1.15 and 1.63 dB at 12 and 18 GHz, respectively. A section outlining developmental prospects for MESFETs notes the promise of ternary and quaternary semiconductor compounds as well as heterostructures. This survey does not cover dual gate MESFETs, cooling, high power modes, nonlinear characteristics or the specifics of transistors used in monolithic devices. The authors are grateful to Yu. F. Sokolov for useful advice in the discussion of the paper. Figures 21; references 142: 24 Russian, 118 Western.

8225/5915
CSO: 1860/41

PARAMETRIC COUPLED SOLITONS IN TRANSMISSION LINES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
 (manuscript received 19 Dec 83) pp 1709-1716

[Article by B. S. Azimov and D. V. Trukhov]

[Abstract] Steady wave states occur during the multifrequency, synchronous interaction of pulses in media exhibiting square-law nonlinearity; the result of such interactions is the formation of combined, nondecaying wave packets. The propagation of a short RF pulse in a transmission line falls within this class of phenomena. This paper theoretically analyzes the effect of the formation of steady-state structures during multifrequency wave interactions and ascertains the soliton nature of the resulting systems. The dynamics of solitary wave formation as well as the evolution of quasimonochromatic wave within the combined packet are described and collisions between solitons and the role of dissipative processes are analyzed. Solitons can be formed that contain five, seven or more discrete frequency components. The numerical studies of actual LC networks clearly demonstrate the new capability of controlling the parameters of short wave packets in transmission lines with a square-law response. Dispersion spreading of a high power pulse can be suppressed through the reactive effect of two weak waves. The soliton-type pulse propagation mode possible in such cases allows a considerable increase in the amount of transmitted information in these lines. The authors are grateful to A. P. Sukhorukov for discussing the results obtained. Figures 6; references 14: 12 Russian, 2 Western (in Russian translation).

8225/5915
 CSO: 1860/41

NUMERICAL MODELING OF STEADY-STATE KINETIC ELECTRON PROCESSES IN
 SUBMICROMETER METAL SEMICONDUCTOR FIELD EFFECT TRANSISTORS

Moscow MIKROELEKTRONIKA in Russian Vol 15, No 6, Nov-Dec 86
 (manuscript received 8 Apr 86) pp 490-501

[Article by N. A. Bannov and V. I. Ryzhiy]

[Abstract] The nonequilibrium electron plasma in submicrometer MESFET elements based on A_3B_5 materials is numerically modeled using a kinetics approach by applying a macroparticle model in which the plasma is simulated by a system of macroparticles, whose dynamic properties are similar to those of actual conductivity electrons. The scattering processes are modeled by a Monte Carlo procedure, by means of which the macroparticles are mapped into the impulse space in accordance with the interaction of the electrons with the impurities

and phonons. The resulting program is written for a BESM-6 computer and contains about 5,000 statements, the majority of which are in FORTRAN with only about 500 in the Madlen autocodes. The technique is applied to the determination of the electron concentrations, velocities and electric fields in a MESFET channel using 10,000 to 50,000 macroparticles with a spatial grid of 121 nodes along the Z axis and 33 Y-axis modes. It is demonstrated that the method can reveal the static, impulse and high frequency parameters of MESFETs and similar IC components as well as ascertain the factors governing their limiting parameters. The authors are grateful to A. A. Samarskiy, K. A. Valiyev and Yu. K. Pozhele for their fruitful comments and useful discussions, Ye. A. Afanasyeva for assisting with the DISPAK operating system, N. G. Belova for useful advice and discussing a number of aspects of the implementation of the macropartical method on the BESM-6, as well as T. G. Yelizarova and Ye. S. Nikolayev for their substantial assistance. Figures 5; references 39: 27 Russian, 12 Western (1 in Russian translation).

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UDC 621.382

LINEARIZATION OF RESISTANCE OF MOS RESISTORS

Moscow MIKROELEKTRONIKA in Russian Vol 15, No 6, Nov-Dec 86
(manuscript received 24 Mar 86) pp 553-556

[Article by V. N. Myshlyayev, I. V. Malyshev and S. V. Kolesnikov]

[Abstract] The nonlinearity of the output characteristic (drain current as a function of drain voltage) of MOS transistors does not permit their use as linear resistors or requires an excessive cutoff voltage (10 to 20 V) at the gate in order to achieve such a resistive mode. These difficulties can be circumvented (the harmonic distortion can be brought below 1% and the working voltage range of the source and drain extended) by applying the half-sum of the drain and source voltages not just to the gate of the MOS resistor, but also to its substrate. This paper analytically demonstrates the feasibility of this technique and shows that the proposed operating mode is readily attained with only an additional 6 to 12 MOS transistors of minimal size in a CMOS LSI device. An additional advantage is the attenuation of nonlinear effects occasioned by the nonlinear channel to substrate capacitance of the MOS resistor. Tables 1; references 10: 3 Russian, 7 Western (2 in Russian translation).

8225/5915
CSO: 1860/76

INDUSTRIAL ELECTRONICS AND CONTROL INSTRUMENTATION

UDC 621.317.39.001.24:531.71

INDUCTION TRANSDUCER OF LINEAR DISPLACEMENTS AND NUMERICAL CALCULATION OF ITS CHARACTERISTICS

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 6, Nov-Dec 86
(manuscript received 18 Feb 86) pp 84-89

[Article by Anatoliy Petrovich Popov, candidate of technical sciences, assistant professor, Omsk Polytechnical Institute, and Olga Pavlovna Kurakina, engineer, Omsk Polytechnical Institute]

[Abstract] The field of two types of a differential induction transducer of linear displacement is investigated: ferromagnetic and conductive cores with excitation of their linearly varying current. A method is developed for numerical calculation using a method of integral equations on a computer, of the basic characteristics of the transducer--the output signal and its sensitivity to displacement. Figures 3; references: 3 Russian.

6415/5915
CSO: 1860/88

INSTRUMENTATION AND MEASUREMENTS

UDC 621.771.014:531.7.67

AXISYMMETRICAL INDUCTION RATE METER

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 6, Nov-Dec 86
(manuscript received 13 Feb 86) pp 89-95

[Article by Leonid Vasilyevich Kazakov, assistant head, Special Design Office of Foundry Machine Construction Plant, Tiraspol; Lev Vladimirovich Pivarov, candidate of technical sciences, assistant professor, Ukrainian Correspondence Polytechnical Institute; and Vladimir Vasilyevich Samobrod, chief engineer, Special Design Office of Foundry Machine Construction Plant, Tiraspol]

[Abstract] Some results are presented of theoretical and experimental investigations of an induction linear rate meter with an axisymmetrical magnetic field and a moving element: a runner consisting of an electrical conducting thin-section cylinder. The dynamic characteristics of the device described are presented and an evaluation is given of its sensitivity, error, and linearity. Methods for improvement of the device are suggested. Figures 4; references: 7 Russian.

6415/5915
CSO: 1860/88

UDC 681.32.08

STRUCTURAL METHOD FOR INCREASING THE PRECISION OF HIGH-SPEED ANALOG-TO-DIGITAL CONVERTERS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 10-12

[Article by T. A. Mustafin]

[Abstract] The article proposes an effective method of digital correction of the systematic errors of parallel-serial analog-to-digital converters. The method provides differential determination of component systematic errors by corresponding algorithms each of which can be utilized independently. The method is characterized by the simple procedure for computing errors of a code in correction mode for which operations of addition and subtraction are necessary instead of the multiplication and division in approximation methods, which considerably decreases the correction time. An additional advantage of the parallel-serial analog-to-digital converter with correction is that its components can be less precise. Figures 2; references 9: 8 Russian, 1 Western.

6415/5915
CSO: 1860/77

UDC 681.3.089.6:519.2

DETERMINATION OF OPTIMUM TIME FOR MEASUREMENT OF THE PARAMETERS OF
NONSTATIONARY SIGNALS BY MEANS OF INTEGRATING DEVICES

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 12-14

[Article by G. P. Bogdanov]

[Abstract] Problems are considered with respect to determining the optimum time for measurement of the current amplitude spectrum of a nonstationary signal. However, it is possible to employ all the relations obtained and the basic conclusions for measurement of analog signals of various physical natures. As a rule the spectral structure of signals is determined with the aid of spectrum analyzers, which possess selectivity with respect to the periodic component of the signal; in the process, the spectral density of the amplitude $S(\omega)$ of the periodic and quasiperiodic signals, restricted in time, have a maximum value at the basic frequencies of these components ω .. Figures 1; references: 4 Russian.

6415/5915
CSO: 1860/77

UDC 531.71.687.92.082.32

PNEUMATIC PRIMARY CONVERTERS FOR MEASUREMENT OF LINEAR DIMENSIONS OF
COMPONENTS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 22-23

[Article by I. D. Salov]

[Abstract] The design is proposed of a converter which expands the technological possibilities of pneumatic measurements in devices of in-process gauging and automatic corrective adjustment. Experimental trials and operational experience on the developed converter showed that its metrological characteristics practically do not differ from widely-used noncontact converters. Movements of the converter with shifting the nozzle practically do not reduce the stability of measurements. The small dimensions, the simplicity of design, and the convenience of attachment makes it possible to use the converter in different measuring devices, among them for multidimensional measurements. Figure 1; references: 2 Russian.

6415/5915
CSO: 1860/77

UDC 539.38.08:66-974

UNIT FOR INVESTIGATION OF THE EFFECT OF STORAGE OF A FORM IN THE TEMPERATURE INTERVAL OF 4.2-300K

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 24-25

[Article by I. G. Zakrevskiy and S. V. Cherepov]

[Abstract] The article describes a device for measuring the sagging of specimens down to helium temperatures by the induction method. The unit consists of a Type KG-100 helium cryostat with a low-temperature measuring module located in it, an electronic system for measuring of a specimen based on a compensator of the Hartshorn bridge type, a Type U2-8 amplifier of signal unbalance, a Type GZ-109 excitation generator, a Type S1-068 reference oscillograph, and a Type PDP4-002 two coordinate registering device. A Cu(Fe)-chromel thermocouple serves for measurement of the temperature. The power supply of the heater and the load-relief of the measuring module is accomplished by Type B5-48 block units. Figures 2; references: 8 Russian.

6415/5915
CSO: 1860/77

UDC 621.373.42

METROLOGICAL CHARACTERISTICS OF GENERATOR OF SINUSOIDAL OSCILLATIONS WITH LINEAR PULSE FEEDBACK

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 48-49

[Article by M. Yu. Mikeyev and B. V. Chuvykin]

[Abstract] A design for improving the stability of amplitude and stabilization of the distortion factor of a sinusoidal generator without nonlinear elements is described. The advantages of the generator considered, together with the traditional features of shapers of a harmonic signal form a sequency of rectangular pulses which facilitate synchronization of the shapers with other transducers, make it possible to use the generator in the composition of information-measuring systems, e.g., for supply of sensors of physical magnitudes. Figures 2; references: 3 Russian.

6415/5915
CSO: 1860/77

UDC 53.089.5:621.317.729.3

PARAMETERS OF PICK-UP BICONICAL ANTENNA

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 51-52

[Article by I. V. Sokolov]

[Abstract] Exact formulas, graphs, and tables are presented for calculation of two basic parameters of a biconical antenna--the input resistance and the effective length. An analytical method is used in the article and a computer is only used for calculations with respect to explicit limited formulas. Use of biconical antennas as a measuring standard makes it possible to reduce substantially the error of calculation of electric field-strength meters. Figures 1; references: 10 Russian.

6415/5915
CSO: 1860/77

UDC 535.3.08:621.375.826

RADIOOPTICAL FREQUENCY BRIDGE OF UNIFIED TIME, FREQUENCY AND LENGTH STANDARD

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 5-7

[Article by Yu.S. Domnin, A.N. Malimon, V.M. Tatarenkov and P.S. Shumyatskiy]

[Abstract] A modernized radiooptical frequency bridge [ROChM] ROChM-101 is described. The ROChM is needed for transferring the standard radio frequency to submillimetric and infrared ranges. Together with a transportable He-Ne/CH₄ laser, it constitutes the most important part of the complex that provides practical implementation of the new definition of meter, adopted by the General Conference on Measures and Weights on October 20, 1983. Block-diagram of the modernized ROChM-101 is presented. The ROChM is located in the same building with the GEVCh [State Time and Frequency Standard]. In December of 1985, new and the most precise measurements of frequencies of HeNe/CH₄ standards were conducted; the accuracy was by an order of magnitude higher, than the one achieved in 1981. The relative error of frequency measurements of transportable standards was equal to 1×10^{-12} and was practically determined by the error of frequency reproduction of these transportable standards. Besides being a necessary component of GEVCh, ROChM-101 is used as GEVCh measuring device for determining frequencies and wavelengths of high-stability generators. The ROChM created the basis for improving accuracy of linear measurements. It has also created new capabilities for conducting various measurements in a wide frequency range, providing the highest presently achievable accuracy of approximately 10^{-12} . Figure 1; references: 9 Russian.

12770
CSO: 1860/283

NONLINEAR DISCRETE SIGNAL PROCESSING IN DEVICES FOR EVALUATION, FILTRATION AND DEMODULATION OF MEASUREMENT COMMUNICATIONS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 11-14

[Article by A.F. Fomin and O.N. Novosyolov]

[Abstract] Demodulation, filtration and noise-immune evaluation as particular cases of a general mathematical problem of demodulation under noise conditions were examined. At present, linear (as far as the isolated communication or noise are concerned) methods of evaluation, filtration and demodulation are mostly used in practice. However, in the general case, and especially in the case of non-Gaussian noise, nonlinear signal processing is required. The problem of optimum non-linear demodulation of analog signals for communications and noise of the most general type, non-Gaussian and non-Markovian, was examined. The derived solution constituted further development and extension of results, obtained earlier for the problem of filtration. The optimum solution of the problem was sought by a criterion of the maximum of a posteriori probability distribution density (MAP) in a recurrent form in the case of discrete observation. A quasi-optimal filtration equation was derived. The block-diagram of a nonlinear modulator that realizes this equation is presented. It is a discrete servosystem, which is either a discrete phase automatic tuning system or a discrete filter, with Kalman filter as a particular case. A posteriori probability distribution was approximated by a unimodal Gaussian distribution. Synthesis of the analog signal demodulator in the case of non-Gaussian communications and noise demonstrated that in the general case an optimum demodulator should constitute an appreciably nonlinear servosystem with several nonlinear transformation blocks. Obtained results could also be expanded to cases of evaluating the information communication parameter in cases of non-Gaussian noise. The efficiency of nonlinear noninertial processing was assessed. In the case of multimodal noise distributions, the processing should include, besides filtration (or evaluation), also a procedure for detection of abnormal measurement results and for corresponding rearrangement of processing device parameters. Figure 1; tables 2; references 8: 7 Russian, 1 Western.

12770
CSO: 1860/283

UDC 621.3.087.92.049:531.1:621.3.049.77.004.14

APPLICATION OF INTEGRAL A/D CONVERTER FOR CONSTRUCTION OF SHAFT DIGITIZER OF SINE-COSINE SYNCHRO RESOLVER

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 15-17

[Article by Ya. M. Belikson]

[Abstract] A construction version of a shaft digitizer [SKVT], using type K572PV1 integral A/D converters [ADC], was examined. The integral circuit of an ADC of this type is a device that operates on a successive approximation method. It is a multipurpose device that determines the possibility of application thereof in an ADC or a DAC [D/A converter] mode, performing a linear or functional transformation. A single-quadrant converter circuit is presented. Converter of the SKVT rotation angle into code basically consists of three functional components: an amplitude detector and a phase discriminator, a synchronization device and a functional ADC. The circuit of the amplitude detector and the phase discriminator of sine-cosine voltages is presented and its operation is discussed. Also presented and discussed is the synchronization device circuit. A single-quadrant converter is the most important component of the device. One integral converter is used in the DAC mode, the other one is used in the ADC mode, wherefrom the DAC is controlled in the process of register-by-register switching. Principal advantages of the proposed converter, compared to similar devices, are as follows: the absence of a reference source, which eliminates errors caused by amplitude normalization and phase adjustment of the reference voltage; relative coding of functional voltage values that makes it possible in principle to use any SKVT with voltage amplitude within the dynamic range of operational amplifiers; converting sine-cosine voltages of SKVT in a wide range (0-90°) of lead phase shift of these voltages relative to line voltage. Figures 3; references 4: 3 Russian, 1 Western.

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UDC 531.74.087.92.082.52

COMPACT PHOTOELECTRIC SHAFT DIGITIZER

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 18-20

[Article by V. G. Domrachev and A. P. Chibukhchyan]

[Abstract] A photoelectric shaft digitizer (TsPU) with information capacity of 12 bit is examined. Its measuring disk had two code tracks, a precise (TO) and a medium (SO) read-out track, and one coarse read-out (GO) track, made in the form of a transparent ring, eccentric relative to the axis of rotation of the digitizer shaft. The main feature of this circular track is simplicity

of manufacturing and sufficient accuracy. Operation of a measurement disk with a circular GO track is analyzed. Its maximum error was equal to 20', which met requirements to a GO track. A complete block-diagram of the TsPU under consideration is presented and its operation is discussed. The use of a measurement disk with a circular eccentric GO track made it possible to reduce the number of tracks to three, use six double photodiodes and six emitters, which in turn made it possible to develop a 12-register TsPU 30 mm in diameter and 35 mm long. Experimental studies of breadboard TsPU prototypes demonstrated the possibility to increase the number of output registers of a GO interpolator, which would make it possible to eliminate the SO track and therefore further reduce the overall dimensions of the digitizer.

Figures 2; references: 3 Russian.

12770/5915
CSO: 1860/283

UDC 621.383.087.92:771.5

DISPLACEMENT DIGITIZERS BASED ON MULTIELEMENT PHOTORESISTORS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 20-22

[Article by V.B. Bogdanovich, A.L. Palamarchuk and S.V. Svechnikov]

[Abstract] A complex of parameters of displacement digitizers (PP), based on well known parameters of multielement photoresistors (M FR), and resulting requirements to elements of optical systems (OS) and the secondary processing block were evaluated. M FR properties, both attained and maximum attainable, were used as a starting point for analysis. Limitations as to topological elements of an M FR code track were formulated. After taking into account physical limitations and manufacturing reproducibility of topological elements, basic topological dimensions of an M FR code track were determined. Various versions of code tracks and methods for combining thereof create a multitude of M FR modifications that differ as to the type of output signals, attained accuracy and the total width of M FR operating field. Some of these modifications were listed and their advantages and drawbacks were discussed. Based on the analysis performed, requirements to parameters of a light line {SSH}, realized with the help of the OS, were formulated. Development of OS with parameters that meet these requirements poses no principal difficulties; moreover, such devices can be realized in compact size. Ways of further improvement of metrological parameters of PP were discussed. The analysis demonstrated feasibility of M FR application in the development of PP with improved metrological and operating characteristics. Based on appropriate sensitive elements, based on PP that contain M FR, one can construct a number of digitizers of physical quantities that can be converted to displacement, such as deformation, level, pressure etc. Figures 2; references : 4 Russian.

12770
CSO: 1860/283

UDC 621.317.7(088.8)

BIREFRINGENCE ERROR IN MAGNETOOPTICAL HEAVY CURRENT CONVERTER

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 50-51

[Article by V.B. Arkhangelskiy, S.F. Glagolev, T.P. Kazakova, L.A. Kuznetsova and M.M. Chervinskiy]

[Abstract] Errors of various types of magnetooptical ammeters were analyzed. Operating principle of these meters is based on measuring the angle of rotation of polarization plane of radiation flux that has passed through a measuring Faraday cell, placed in the magnetic field of current to be measured. The phase measurement method was the most efficient in measuring heavy currents. Under this method, the range of measured currents is only limited by the range of recorded phase shifts and is therefore much wider than in the case of using photocurrent and compensation methods. Metrological characteristics of an ammeter depend to a large degree on the design of the measuring Faraday cell. When measuring current by any of the above methods, polarization state of the output optical signal changes, due to birefringence in glass rods or fiber light guides of the cell and to anisotropy of rotational systems of a rod cell. In order to examine the effect of birefringence on the measurement result, a measuring Faraday cell was presented in the form of a model that included an ideal polarization plane rotator and ideal linear phase plate. This model was analyzed and the birefringence error was determined. When using the first two of the above measurement methods, the birefringence error was as high as several percent, which limits application of those methods. In the case of high birefringence, the photocurrent method is preferable due to a simpler converter design. When the phase method is used, there is no birefringence error and the range of measured currents is much wider, therefore this method is more suitable, despite complex modulator design. Figures 2; references 5: 4 Russian, 1 Western.

12770
CSO: 1860/283

UDC 621.316.84.089.5

CONTROLLING PARAMETERS OF FOIL RESISTORS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 55-56

[Article by N. N. Glukhov]

[Abstract] Characteristics of industrially manufactured S5-61 precision foil resistors were examined in order to determine whether they met requirements of OZhO 467.561 TU specifications. Because the specifications did not contain data on requirements to resistance measuring instruments and certified

resistance measurement procedures, an attempt was made to formulate requirements to instruments for measuring resistance of type S5-61 resistors with admissible deviation from the nominal value of + or - 0.005%. Analysis revealed discrepancies in the specifications and difficulties, encountered by users of these resistors in testing the resistance thereof. It was concluded that the existing precision of foil resistors was unsatisfactory and that the situation should be changed. It was proposed to call those resistors "precision resistors" that have deviation from the nominal value of not more than 0.05%. Additional specifications were also proposed. It was suggested that implementation of the above proposals would make it possible to objectively evaluate resistor quality and reject potentially unreliable resistors. It was also suggested to call S5-61 resistors "improved accuracy resistors", "improved stability resistors" or "improved stability and accuracy" resistors, rather than "precision resistors". References: 2 Russian.

12770
CSO: 1860/283

UDC 65.011.56.012.7:621.385.6.089.5

SYSTEMS FOR AUTOMATIC MEASUREMENT AND CONTROL OF PEMS IN NONLINEAR VHF DEVICES

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 56-59

[Article by Ye.A. Yegorov and V.I. Pyatayev]

[Abstract] An integrated automated system for measurement and control of noise immunity and magnetic compatibility (PEMS) of individual VHF components and VHF equipment as a whole was analyzed. Requirements to such systems were presented. The problem of studying and controlling PEMS in PUU [receiving-amplifying devices] was formulated in a general form. An integrated automated system, developed by the authors earlier, can be adapted for solving a broad class of problems, generated at various stages of scientific studies, design and manufacturing of VHF radio equipment. A simplified block-diagram of this system was presented. The use in the system of generators of stimulating oscillations with broad functional capabilities makes it possible to conduct integrated studies and control of a large class of linear and nonlinear VHF components and devices, including studies of intermodulated and combination distortions, transformation of higher harmonics, radio pulses envelope distortion, amplitude-phase conversion etc. Measurements of the dependence of a travelling wave amplifier gain on the length and amplitude of radio pulse noise demonstrated that noise immunity of the amplifier depended not on power but on energy of noise that gets into the amplifier bandwidth. Measurement error was determined by meter errors. A Ch3-54 frequency meter and an M3-51 wattmeter were used. In the analyzed examples the error did not exceed 15-20%. Experimental operation of the developed system demonstrated the possibility to significantly increase productivity of scientific studies, control and testing of radio equipment PEMS. Thus, when manual control mode was changed to automatic control, time for testing VHF mixers was reduced from several hours to several minutes. Figures 2; references 14: 12 Russian, 2 Western.

12770
CSO: 1860/283

MICROWAVE THEORY AND TECHNIQUES

UDC 621.385.632.14

DESIGN OF 'RADIAL COMB' SLOW WAVE STRUCTURE USING IMPEDANCE APPROXIMATION

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 30 Oct 84) pp 1854-1856

[Article by L. N. Loshakov, Yu. N. Pchelnikov and M. A. Zima]

[Abstract] Microwave band heating equipment employs "radial comb" slow wave structures in which the space between the structure and the shield contains the object to be heat treated. This paper analyzes the propagation of an axially symmetric slow electromagnetic wave in such a system at frequencies low enough for impedance boundary condition to be applied at the comb surface. Losses are disregarded and the shield is assumed to be an ideal conductor. A simple analytical expression is found for the retardation of the phase velocity and the dispersion parameters are graphed as a function of the device geometry. The constraints on the applicability of the impedance approximation are defined analytically, though no numerical sample calculations are provided. Figures 2; references: 2 Russian.

8225/5915
CSO: 1860/41

UDC 621.372.832.8

CALCULATION OF PARAMETERS OF H-PLANE WAVEGUIDE T-ISOLATORS FOR SHORTWAVE PORTION OF MILLIMETER BAND

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 4 Jun 85) pp 1856-1857

[Article by G. S. Yatskar]

[Abstract] A computer program for determining the electrodynamic parameters of H-plane waveguide isolators using T-couplers in the 8 mm band is precise enough for engineering applications when extended to the upper limit of the millimeter band. The following parameters of an H-plane T-isolator are calculated and graphed for frequencies of 65 to 69 GHz, 133 to 139 GHz and 263 to 275 GHz: the isolation of the main circulator, the isolation of the isolator assembly, the reflection factor of the absorbing load in the waveguide arm on the axis of symmetry of the T-coupling, the voltage standing wave

ratio and the forward losses of the isolator. Circulator isolation ranges from 4 to 6 dB within the passband; the VSWR was less than 1.3; the forward losses were less than 1 dB. These figures were attained by selecting the optimal absorbing load reflection factor as a function of frequency, resulting in an isolator rated at better than 20 dB. Figures 1; references: 3 Russian.

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PRECISION OF SPACE CHARGE FIELD COMPUTATION IN MICROWAVE BEAM DEVICES

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 28 Sep 84) pp 1867-1870

[Article by I. A. Mankin and B. L. Usharovich]

[Abstract] While the large particle analysis based on the use of Green's function has been successfully employed to devise a computer algorithm for calculating the space charge field in microwave beam devices, the previous use of a linear interpolation between the fields for the case when the large particles either overlap or touch introduces considerable error. This paper derives better approximations and exact formulas for the space charge field and compares the results of their application to those from the earlier linear interpolation. The maximum relative error in the radial field calculation using the linear interpolation is no more than 10%; switching from this interpolation to the more precise formulas does not involve any increase in machine time. While linear interpolation exhibits consistently poorer accuracy, the average error using the proposed improved formulas is 6.7% for the longitudinal and 1% for the radial field (as opposed to 9.5% and 2.7% respectively for the linear interpolation). The proposed method for rapid computation of the space charge field is shown to exhibit small errors (5.8% for the longitudinal and 0.5% for the radial component), even in the case of a separable charge density function, i.e. under conditions of a strongly bunched electron flow. Figures 4; references 4: 3 Russian, 1 Western (in Russian translation).

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BIOLOGICAL EFFECTS OF LOW INTENSITY MILLIMETER WAVELENGTH RADIATION

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 24 Mar 86) pp 4-10

[Article by O. V. Betskiy and A. V. Putvinskij]

[Abstract] This paper surveys the causes and biological effects of low level (1 to 10 mW/cm²) millimeter wavelength radiation (100 to 1,000 GHz) absorbed by biological systems. Millimeter energy can be converted to polar molecular energy (related to rotational degrees of freedom as in polar water molecules having a dipole moment of 1.84D that effectively act as energy storage systems). The energy can also be stored via a resonant mechanism, since biological systems can have polarization (dipole) oscillations at these frequencies and various vital processes in cells impart energy to locally excited dipole oscillations and because of the nonlinear effects of the interaction of such oscillations and the nonlinear coupling of these oscillations to elastic oscillations, the system can shift to a metastable state in which the energy is converted to a singular kind of oscillatory energy. The metastable oscillation can change to a primary oscillation, creating a "gigantic" dipole. Such a model assumes that these oscillations encompass portions of biological membranes or macromolecules. Such a state is a single quantum state reminiscent of low temperature Bose gas condensation. These two factors are responsible for the most important feature of millimeter emissions: the impact of nonthermal, low level biological effects in which the temperature of the irradiated sample does not exceed 0.1°C. Cumulative, resonant, therapeutic and other effects are detailed along with an analysis of the disruption of the additivity of millimeter wavelength absorption by aqueous solutions. Primary attention is devoted to the phenomenon of convective mixing of aqueous solutions exposed to such emissions. The sensitivity threshold of biological systems to CW millimeter emissions is 1 to 10 mW/cm². A number of the effects are due to the more selective absorption of this radiation by H₂O molecules, producing fluid convection. The experiments that have been conducted with a variety of simple model systems confirm the notion that frequency-dependent (resonant) effects of the emissions are a property of complex biological systems. Figures 6; references 12: 9 Russian, 3 Western.

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ANALOGY BETWEEN CERTAIN SYSTEMS OF LIVING ORGANISMS AND MICROWAVE ELECTRONIC DEVICES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 13 Jan 86) pp 10-19

[Article by M. B. Golant and T. B. Rebrova]

[Abstract] The application of electronic and cybernetic concepts to the therapeutic use of low power (nonthermal) millimeter wavelength electromagnetic radiation requires an understanding of the informational organization of the affected biological systems. This paper draws parallels between the organizational principles of certain microwave devices and the therapeutic response of the information systems of living organisms. Such analogies are useful in explaining the nature of the impact of the frequencies to which cellular membranes are exposed (the role of resonances in such membranes) and the fact that the response of an organism to these emissions is not necessarily a function of the intensity (since the issue is one of the synchronization of the oscillations in the membranes rather than the effect of the input energy on the cellular processes), assuming the input power is above some low threshold level. The necessity of long term exposure for therapy in obtaining a lasting effect is due to the restructuring in the cells which requires energy and the raw materials delivered to the affected site only during the processes of metabolism. The coupling of the electromagnetic oscillations excited in cell membranes to the ambient medium and the way in which membranes perform process control functions in the cells are also discussed. Figures 4; references 23: 17 Russian, 6 Western (1 in Russian translation).

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MODELING NONLINEAR PROBLEMS OF SEMICONDUCTOR MICROWAVE ELECTRONICS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 15 Dec 85) pp 20-27

[Article by Yu. L. Khoduntsev]

[Abstract] The operating principle of an extensive class of microwave devices (amplifiers, synchronized and self-excited oscillators, frequency multipliers and converters, phase shifters, switching and safety devices) is governed by nonlinear phenomena. The requirements placed on the design of the semiconductor devices used in such systems can be divided into two groups: 1) Assure the requisite power and phase parameters at the required frequencies, temperatures and with system parameter variations. The power and phase characteristics as well as the dependence of the phase on the amplitude are found

from the determination of the multifrequency steady-state operating mode of the nonlinear system; 2) Assure spectral purity: a) Requirements placed on fluctuations at the device output; b) Requirements that there be no parasitic component due to instability of the operating mode; c) Requirements placed on the level of combination and intermodulation distortion products. This paper is a compact review of the impact of imperfections in the circuit models of a variety of such semiconductor devices (FET and bipolar transistors, Schottky barrier and Gunn diodes, varactors, IMPATT diodes, tunnel and PIN diodes as well as MESFET's) on the ability of the resulting circuit design to meet the above requirements. This review enumerates several problems that must be resolved in order to determine the parameters of particular types of semiconductor devices and develop CAD programs for such nonlinear devices. References 40: 26 Russian, 14 Western (2 in Russian translation).

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MAJOR TRENDS IN MODELING SUBMICROMETER SCHOTTKY BARRIER GATE FIELD EFFECT TRANSISTORS (REVIEW)

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 13 Feb 86) pp 28-42

[Article by G. V. Petrov and A. I. Tolstoy]

[Abstract] Attention is focused in this review of MESFET models on the physical effects in submicrometer structures and the techniques that make it possible to consider these effects when modeling this type of device. The following effects become significant with a reduction in the gate length to the size of submicrometer structures: high charge carrier mobility in selectively doped heterostructures as well as ballistic transport and velocity overshoot; the impact of the depletion region-channel and channel-substrate boundaries, the actual doping concentration profile and the mobility in the channel as well as the influence of parasitic elements of the MESFET structure. This thorough survey of Soviet and Western literature indicates that the best approach to the simulation of mobile charge carrier drift velocity overshoot is the use of an impulse and energy balance equation that is sufficiently precise if the primary parameters of the model are determined by the Monte-Carlo method. When determining the parameters of selectively doped heterostructures, one must take into account several equivalent and nonequivalent subbands in the conductivity band as well as the existence of a greater number of scattering mechanisms than in the case of the usual semiconductor. The accuracy of submicrometer MESFET models can be improved if one considers the nonuniform nature of the doping distribution in the channel and the influence of depletion region-channel and channel-substrate boundaries. These models are broken down into three groups: one-dimensional, quasi-two-dimensional and two-dimensional. The quasi-two-dimensional models enable the consideration of

practically all of the effects occurring in these devices and are less cumbersome than the two-dimensional models. The latter (especially Monte-Carlo based versions) will be used to gain a deeper understanding of MESFET performance and study the semiconductor structure prior to fabrication and test the viability of simpler models. Figures 10; references 81: 21 Russian, 60 Western.

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STRUCTURAL COMPONENTS AND EFFICIENCY OF OSCILLATOR SYSTEMS OF SOLID-STATE MICROWAVE OSCILLATORS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received after revision 12 Jul 85) pp 43-49

[Article by S. A. Zinchenko and Ye. A. Machusskiy]

[Abstract] The output power of such microwave oscillators as IMPATT and tunnel diodes can be increased during the oscillator design by optimizing the structure and individual components of the oscillating system in order to boost the energy delivered by the active device and enhance its coupling to the load with minimal losses. This paper defines the sources of losses in microwave oscillator structures and the impact of these losses on oscillator efficiency when using various matching techniques. Some 10 difference circuit configurations for the active device power supply lead-in are discussed. Equivalent circuits are given for impedance matching structures and it is shown that oscillator designs employing impedance transformation in the active device circuit provide the best efficiency, because of the lesser impact of losses in the power supply leads and mounting hardware. Oscillators using impedance transformation in the base transmission line are in principle subject to reduced efficiency because of the complete inclusion of the wiring and power lead loss resistances in the circuit. Intermediate efficiencies are inherent in microstrip line transforming networks and coaxial stub type transformer oscillators. This comparative analysis of oscillator types adduces neither specific hardware examples nor design equations. Figures 7; references 4: 3 Russian, 1 Western.

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STUDY OF METHODS FOR SOLVING SELF-CONSISTENT PROBLEM IN COUPLED-CAVITY TRAVELING WAVE TUBE TYPE DEVICES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 29, No 10, Oct 86 (manuscript received 7 Jun 85) pp 61-66

[Article by A. V. Osin, V. V. Podshivalov and V. A. Solntsev]

[Abstract] While a number of programs have been written for computing the interaction of electrons with the fields of periodic slow-wave structures in coupled-cavity traveling wave tube and Twystron type devices, regardless of the mathematical model used for describing the interaction, the solution of the resulting nonlinear boundary value problem encounters significant obstacles. The solution of the self-consistent problem requires an iteration procedure in order to satisfy the boundary conditions, i.e., a numerical solution of the nonlinear equations. This paper formulates and solves three basic problems: the study of the relief of the objective function for various operating modes in order to ascertain the reasons for the divergence of the iteration procedure and determine the requisite precision in the specification of the initial approximation; the study of the possibility of specifying the initial approximation by means of sequentially changing over from a linear operating mode, where convergence is assured, to the nonlinear case; the development of an efficient method for solving the nonlinear boundary value equations, which converges in all modes, regardless of the initial approximation, chosen in a region determined by the physical constraints placed on the interaction process. The algorithm constructed here is independent of the objective function relief and was applied to the solution of TWT design problems. Only 20 to 30 iterations are needed for convergence. Figures 4; references 5: 4 Russian, 1 Western.

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MULTIPLE PERIOD NUMERICAL MODEL OF DISTRIBUTED EMISSION MAGNETRON AMPLIFIERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian Vol 29, No 10, Oct 86 (manuscript received 31 Jul 85) pp 72-79

[Article by A. A. Terentyev, Ye. M. Ilin, and V. B. Bayburin]

[Abstract] The majority of numerical models using the "large particle" method to describe the processes in crossed fields are based on a single period approximation: the electron and wave interaction is simulated in a sector equal to the slowed wavelength and moving at the phase velocity of the wave. However, such models, while computationally efficient for forward wave amplifiers, are not effective for backward wave amplifiers. This paper proposes a

numerical model for distributed emission, cylindrical magnetron amplifiers (e.g. the amplitron) based on the application of the "large particle" method simultaneously throughout the working space of the device. The volt-ampere and working characteristics are calculated for amplitrons as well as the cathode and anode losses along the length of the device. The degree of electron flux demodulation in the drift region is estimated. A FORTRAN program requiring 300 Kbytes running on a YeS1060 computer simulates the processes in one RF period in an amplitron in 5 to 8 minutes, while 10 to 14 minutes are needed for a forward wave drift space amplifier. Computed and experimental curves for the efficiency, output power and anode voltage as a function of the anode current show good agreement. Figures 5; references 10: 8 Russian, 2 Western.

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UDC 537.8

NONTRADITIONAL APPLICATIONS OF SLOW-WAVE STRUCTURES

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 20 Jun 85) pp 79-83

[Article by Yu. N. Pchelnikov]

[Abstract] While slow-wave structures find applications in linear accelerators, traveling wave parametric amplifiers and even as antennas, the physics of electromagnetic wave retardation in these devices holds promise for even more extensive, nontraditional applications: miniature stripline cavities (with resonant frequencies down to 25 MHz), couple-comb power splitters, RF and microwave heaters in which the heating is accomplished primarily by the electric field or magnetic field, depending on the conductivity of the heated materials (the Elektronika-500 microwave furnace is an example of such a heater using a radial comb configuration). Slow-wave systems can also be used to measure the electrical parameters of materials (resistance, permittivity and permeability). The use of such structures as the sensing elements of primary transducers is quite promising; the first such transducer was made in the form of a coil wound on a dielectric tube, with the coil inserted in the feedback network of an oscillator with delayed feedback in a system for monitoring the continuity of dielectric fluid flows. Coupled slow-wave structures can be used in devices insensitive to the dielectric properties of the environment, in particular, ice and moisture. An urgent design problem though is the development of a method of calculating the parameters of slow-wave systems that would allow the consideration of the geometry of the slow-wave conductors and the ambient parameters in a relatively low-frequency approximation. While only the first steps have been taken towards the development of an "equivalent line" technique for this, the great interest in nontraditional applications necessitates the further development of the technique. Figures 4; references 12: 10 Russian, 2 Western (in Russian translation).

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NUMERICAL SIMULATION OF MICROWAVE POWER LIMITING DIODE

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 24 Mar 86) pp 84-86

[Article by N. I. Filatov and A. S. Shnitnikov]

[Abstract] Power limiter diodes such as those used in the front ends of radars are usually PIN types. This paper uses a one-dimensional, isothermal diffusion and drift model of such diodes in order to take into account the effects of heavy doping and high injection level in determining diode performance in power limiting applications. The model algorithm employs a finite difference approximation of the initial equations and linearizes the resulting nonlinear system by Newton's method in order to obtain a system of linear equations in terms of small increments in the unknown distributions of the charge carrier concentrations and electric field intensity. The theory is applied to the calculation of the limiting behavior of a simple diode equivalent circuit: a diode in parallel with a load impedance of 400 ohms and in series with a line impedance of 400 ohms and a microwave voltage source producing 100 and 900 V at 9.375 GHz. A drift model of the electron and hole motions in the case of forward bias is more correct than the diffusion model. The algorithm can analyze the waveform over several signal periods on a SM-4 computer in less than 20 minutes. The greatest reduction (about 25%) in the positive amplitude is achieved during the first three periods; the subsequent change (out to the ninth period) does not exceed 1.5%. The constraints of the simplifying assumptions in the model are also discussed, though the accuracy is good enough for engineering applications. Figures 3; references 5: 2 Russian, 3 Western.

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OPTIMIZATION OF POWER PARAMETERS OF MICROWAVE VARACTOR MIXERS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 22 Jul 85) pp 86-89

[Article by A. Ye. Ryzhkov and I. Ye. Chechik]

[Abstract] Modulation at the intermediate frequency and subsequent up conversion of the signal to microwave frequencies is widely used in microwave transmitters. Such designs require an increase in the mixer output power in order to reduce the number of amplifier stages. This paper mathematically analyzes the performance of reverse biased, GaAs varactors in order to optimize such mixers with respect to the output power and the efficiency. Two problems are solved: scalar optimization with respect to the output power and vector

optimization with respect to the output power and efficiency. It is shown that optimal power and efficiency require that the load impedance increase with the loss resistance. The calculated equivalent impedances of optimally moded varactors used in such mixers enable the design of microwave matching networks so as to match the local oscillator and the load to the circuit diodes. Equations are given for calculating the actual power levels delivered to the diodes, the output power and the equivalent resistances of the diodes at the working frequencies. Figures 4; references 6: 4 Russian, 2 Western (1 in Russian translation).

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OPTIMIZATION OF PHASE-FREQUENCY AND AMPLITUDE-FREQUENCY RESPONSE OF SEMICONDUCTOR MICROWAVE AMPLIFIER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian Vol 29, No 10, Oct 86 (manuscript received 9 Jul 85) pp 90-92

[Article by V. I. Kaganov and S. N. Zamuruyev]

[Abstract] The equivalent circuit of a microwave amplifier is drawn as an active device (transistor or diode) and two matching and filter networks. General analytical expressions are found for the phase and frequency response of the circuit. The central component of the amplifier design program is an objective function that reflects the essence of the solution to the problem of optimizing the matching circuit in accordance with the chosen criterion: this objective function is written in terms of the divergence between the requisite and actual responses using the sum of the squares of the differences. The program is applied to the specific case of a matching and filter network consisting of cascaded long microstrip lines, joined together by one of three components: a short-circuited or open-circuited loop, or a capacitance. The capacitive case is run as a sample calculation for working frequencies of 200 to 400 MHz, a load impedance of $(15 - 0.015f) + j0.015f$ ohms, a substrate dielectric permittivity of 10, a substrate thickness of 2 mm, a power gain of 0.8 and an internal impedance of the signal source of 50 ohms. The frequency and phase response curves are graphed, showing reasonable matching of the theoretically desired and computed response curves. Figures 4; references 3: 1 Russian, 2 Western (in Russian translation).

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SOLID STATE WAVEGUIDE PHASE SHIFTER WITH RESONANT ARRAY AS CONTROL ELEMENT

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 7 Dec 85) pp 94-95

[Article by A. S. Petrov, V. V. Povarov and I. V. Lebedev]

[Abstract] Reflective waveguide diode phase shifter usually employed modular slot assemblies or loop switches as the control elements. The power level delivered to the phase shifter can be boosted by using a resonant array as the control element. The requisite phase shift is accomplished through the choice of the electrical length of a shorted section, though it is more difficult to minimize the difference in the phase shifter losses in the on and off states. This paper describes a computer-aided approach to the design of resonant arrays that results in equal losses in the on and off states of such control devices. An experimental check with a 23 x 10 mm cross-section waveguide, transverse dimensions of the array rods of 2 x 2 mm and employing type 2A520 diodes as the switches confirms both the design method and the fact that waveguide, reflective type phase shifters can be designed with a resonant array as the control element and the electrical parameters of such phase shifters are as good as traditional devices, while they have an increased controlled signal power that is approximately proportional to the number of diodes used. Figures 3; references 5: 4 Russian, 1 Western.

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FREQUENCY DEPENDENCE OF MODULATION SENSITIVITY OF GUNN DIODE OSCILLATORS

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 17 Jun 85) pp 50-55

[Article by V. N. Dubrovskiy and A. S. Karasev]

[Abstract] Since Gunn diode oscillators exhibit a slope of the FM modulation characteristic that is a function of the modulating signal frequency, generally decreasing with an increase in the frequency, though in some cases increasing with a frequency decrease, it is important to determine the factors influencing the types of diode oscillation. This paper ascertains the diode and oscillator circuit parameters that govern the dependence of the modulation index rate of change on the supply voltage and the modulating signal frequency. It is assumed that the fundamental cause of this frequency dependence is the thermal inertia of the Gunn diode and, because of this dependence, there is a phase shift between the frequency modulating the signal and the change in the oscillation frequency, thus making the slope of the modulation index characteristic a complex quantity. The modulation sensitivity of 3 cm band oscillators

was measured in a range of 10 Hz to 10 MHz, when the diodes were mounted in a waveguide and stub oscillator cavity loaded in a matched load having a Q of about 200. The RF voltage across the diode did not exceed 0.1 V. The modulating sensitivity in MHz/V is plotted as a function of the modulating frequency between 10 and 10^6 Hz. In this frequency range, the modulation sensitivity is determined by the diode parameters, its internal structure, the heat sink configuration and the oscillation circuit parameters. The expressions given here can optimize the choice of the diode supply voltage and circuit specifications in order to achieve wideband frequency modulation. Figures 4; references 6: 3 Russian, 3 Western (1 in Russian translation).

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CALCULATING OPERATING MODE OF VARACTOR IN HIGH POWER UP-CONVERTER

Kiev IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIODELEKTRONIKA in Russian
Vol 29, No 10, Oct 86 (manuscript received 22 Apr 85) pp 55-61

[Article by Yu. G. Tityukov and V. A. Yakovenko]

[Abstract] The diode used an overdriven varactor upper sideband up-converter operating at maximum power is modeled with a simplified equivalent circuit: the loss resistance is in series with the nonlinear capacitance of the diode. This model is analyzed to calculated diode operating conditions for arbitrary excitation levels and diode parameters. Engineering equations are derived for the power and impedance parameters of an optimally moded diode. Tables summarize the normalized diode parameters in the maximum output power and maximum efficiency modes, permitting the rapid calculation of operating conditions in such up-converters, knowing only the data sheet specifications for the diode. Figures 2; references 6: 2 Russian, 4 Western (1 in Russian translation).

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OPTIMIZATION OF PATH FOR TRANSMISSION OF ENERGY BY A MICROWAVE BEAM

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 3 Jun 86) pp 17-20

[Article by V. A. Vanke, S. K. Lesota and A. V. Rachnikov]

[Abstract] High efficiency (efficiency factor more than 90%) is one of the principal requirements of a path for transmission of energy by an electromagnetic beam. The present article solves a problem with respect to the maximum efficiency factor of energy transmission between apertures with a fixed ratio of the maximum power density at the receiving antenna to the power density at its edge. Polar diagrams of a non-Gaussian type are derived with a "gap" of the intensity of the field at the axis of the beam, which makes it possible to provide a large efficiency factor for the receiving antenna and a high level of the transmitted power. Figures 3; references 8: 5 Russian, 3 Western (1 in Russian translation).

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COMMUTATION CHARACTERISTICS OF MULTICHANNEL WATER-DISCHARGE ARRESTERS

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 6, Nov-Dec 86
(manuscript received 29 Jan 86) pp 3-9

[Article by Nikolay Kuzmich Kapishnikov, candidate of technical sciences, senior scientific research worker, Scientific Research Institute of High Voltages, Tomsk; Georgiy Vladimirovich Lipov, junior research worker, Scientific Research Institute of High Voltages, Tomsk, and Vasily Mikhaylovich Muratov, candidate of technical sciences, head of laboratory, Scientific Research Institute of High Voltages, Tomsk]

[Abstract] On the basis of a generalization of experimental data, an a priori evaluation is made of the commutation characteristics of multichannel air-gap arresters with liquid insulation. The calculated expressions obtained were approved during tests of a low-resistance generator of high-power nanosecond pulses switched by a 12-channel water-discharge arrester of the trigatron type. The experimental and calculated data obtained agree satisfactorily. Figures 3; references 14: 13 Russian, 1 Western.

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UDC 621.3.045.16(088.8)

EXTERNAL MAGNETIC FIELD OF HARMONIC CURRENT DISTRIBUTION ON A CYLINDRICAL SURFACE OF FINITE LENGTH

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 6, Nov-Dec 86
(manuscript received 20 Nov 85) pp 9-14

[Article by Vladimir Vasilyevich Sotnikov, candidate of technical sciences, senior teacher, Mariysk Polytechnical Institute, Yoshkar-Ola]

[Abstract] The article considers the problem of calculating the external magnetic field (EMF) of a harmonic surface current. An approximation by the surface currents of the windings, of eddy currents is a widely used procedure during calculation of EMF, e.g. of electrical machines. An expression is obtained for the magnetic potential in a spherical system of coordinates, in

the form of a series expansion with respect to magnetic multipoles. Conclusions are drawn concerning the nature of the distribution of the potential in space. The use is shown of the expressions obtained for calculating the external magnetic field of windings and of eddy currents. Figures 3; references: 4 Russian.

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UDC 621.314:629.423:621.382:2/3

INVESTIGATION OF THE PROCESSES OF SWITCHING OFF AND ANALYSIS OF POWER THYRISTOR FAILURES

Kiev TEKHNICHESKAYA ELEKTRODINAMIKA in Russian No 6, Nov-Dec 86
(manuscript received 9 Dec 85) pp 19-23

[Article by Vladimir Antonovich Muzykin, candidate of technical sciences, assistant professor, Dnepropetrovsk Institute of Railroad Transport Engineers; I. F. Vasilyuk; Vladimir Aleksandrovich Shapovalov, junior research worker, Dnepropetrovsk Institute of Railroad Transport Engineers; Viktor Teodovich Zagorskiy, candidate of technical sciences, head of division, Novosibirsk Scientific Research Institute of Enclosed Electric Drives; and Viktor Markovich Shevchenko, candidate of technical sciences, assistant professor]

[Abstract] The results are presented of experimental investigations of the reverse recovery charges Q_{rr} and the switching-off time t_q of batches of T630 and T353-800 thyristors. For an especially selected batch of T353-800 thyristors, the typical dependences are shown of the parameters t_q and Q_{rr} on the temperature of the structure, as well as the dependence of the parameter t_q on the build-up increase of repeated stress in a cut-off state. Conclusions are drawn with respect to the increase of a tendency towards failure of thyristors which have a large value of the reverse recovery time. Figures 5; references: 5 Russian.

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STREAMER DEVELOPMENT MECHANISM IN SHARPLY INHOMOGENEOUS ELECTRIC FIELD

Moscow ELEKTRICHESTVO in Russian No 11, Nov 86 (manuscript received 22 May 86)
pp 27-33

[Article by E. M. Bazelyan and A. Yu. Goryunov]

[Abstract] The mechanism of long streamer propagation in a sharply nonuniform electric field is one of the most difficult questions of spark discharge theory and two models are found in the literature: 1) Quasi-wave motion of the charged head, that does not leave a conductive channel behind it and creates conditions for shock ionization at the wave front, because of the high unipolar charge concentration of the head; 2) Formation of a high-conductivity channel, because of which, there is local amplification of the field at the streamer head. The first model is contradicted by numerous experiments demonstrating streamer propagation over several meters in fields with an intensity of less than 7 kV/cm as well as other data showing a constant average intensity over the length of the streamer when the interelectrode spacing and initial distribution change. Reasons for rejecting the second model are also adduced and this paper proposes a third model incorporating the best elements of both models. It is assumed that streamer propagation does not require galvanic coupling between its head and the initiation point. Moving across a gap, a streamer leaves an ionization channel with a nonequilibrium, nonsteady-state plasma behind the front; the electron concentration in this plasma falls off continually. If the streamer development time is long enough, the time must come when the plasma decays at the anode and the conducting portion of the channel following the head breaks in the depth of the gap. After this, the amplification of the intensity at the head needed to sustain the ionization can be achieved only by means of polarization in the electric field of the discharge gap of the plasma element that has still not lost its conductivity. This qualitative discussion notes that a quantitative description of the proposed collective model encounters some difficulties related to the analysis of the restoration of the electric field in the decaying streamer plasma, the conditions for the initiation of subsequent streamers and the static nature of the processes defining their trajectories. Although the available experimental data do not allow a complete transition from the qualitative model to theoretical calculations of streamer region parameters, they enable the determination of the major trend of the variation in propagation parameters as a function of the composition and state of the medium in the discharge gap, its length and the time parameters of the voltage pulses. Figures 6; references 31: 20 Russian, 11 Western (3 in Russian translation).

8225/5915
CSO: 1860/78

APPLICATION OF ABSORPTION METHOD TO MONITORING OF PAPER INSULATION
IMPREGNATION PROCESS FOR POWER CABLES

Moscow ELEKTRICHESTVO in Russian No 11, Nov 86 (manuscript received 27 May 86)
pp 66-68

[Article by M. Ye. Iyerusalimov, doctor of technical sciences and L. A. Kovrigin, candidate of technical sciences]

[Abstract] A new method of real-time monitoring of the process of impregnating the paper insulation of 20 and 35 kV power cables during their manufacture has been implemented in the plant technical management automation system for drying and impregnating power cables developed for the Kamskiy Cable Plant imeni 50th Anniversary of the USSR. The process is based on the fact that a two-layer cylindrical capacitor is formed during the impregnation of the insulation paper, where the separation boundary between the impregnated and non-impregnated insulation moves from the outer surface of the insulation to the current conducting core. The two-layer dielectric is characterized by the absorption current, the rate of its decay and the absorption capacitance. The absorption current is the essential parameter measured that is used to determine the extent of paper impregnation; the sensing time constant in this case is no more than 0.35 s and this current can be measured automatically. The instrumentation algorithm is described in detail, though the specific circuit design is not shown. Figures 3; references: 5 Russian.

8225/5915
CSO: 1860/78

QUANTUM ELECTRONICS, ELECTRO-OPTICS

UDC 621.378.325

DYNAMIC PARAMETERS OF PREDICTIVE ADAPTIVE OPTICAL SYSTEMS

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 22 Oct 84) pp 1808-1812

[Article by V. P. Lukin]

[Abstract] A linear adaptive optical system is a dynamic system with a feedback loop and thus has a limited bandwidth, i.e. a finite response time. This means that phase measurement data are determined by the resulting changes in the phase profile of the adaptive optics (e.g. an adaptive mirror) during some time delay. The problem of determining the requisite bandwidth of the entire optical system can be approached as a problem of predicting the random wave phase distribution at a point in time after the onset of the delay based on the optical measurement data taken prior to the phase delay. This paper proposes three statistical prediction schemes for calculating the random phase distortions and the errors in the estimation of the average field and its intensity for the case of a constant time delay. By knowing the a priori time correlation functions of the fluctuations of the modal components of the phase, the dynamic time parameters of the system can be improved and the impact of residual distortion reduced through the time delay in the feedback loop. The computation of a prediction in which the measurement data are used from different points in time is possible, though this procedure will not significantly improve a forecast. No design examples or sample calculations are cited in this theoretical treatment. Figures 3; references 13: 6 Russian, 7 Western (1 in Russian translation).

8225/5915
CSO: 1860/41

UDC 621.396.67:778.38

HOLOGRAPHIC SYSTEM WITH ANNULAR RECEIVING APERTURE

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 28 May 84) pp 1839-1847

[Article by A. Ch. Belyachits, P. D. Kukharchik and V. G. Semenchik]

[Abstract] Two-dimensional arrays of detecting elements or crossed linear transmitting and receiving arrays can be used to generate a hologram and then with digital image reconstruction techniques enhance the speed of long wave holographic imaging systems. Minicomputers can be used for the storage of the large requisite volume of input data, though memory constraints suggest that it is better to increase processing speed by reducing the amount of input data. This can be done by selecting the appropriate receiving aperture, using an optical system with an entrance pupil in the form of a ring to generate two-dimensional images. Since the ring can be represented as a circle in the limiting case, this paper demonstrates the possibility of reconstructing two-dimensional images of satisfactory quality using radioholography by means of making the receiving aperture in the form of a circle. A comparison is drawn between a solid circular aperture and the annular aperture: the latter is inferior to the former in general, the ring aperture nonetheless significantly reduces the number of points at which the parameters of the field scattered by the target must be measured and also has better resolution. A substantial drawback to the annular aperture is the high sidelobes of the ambiguity function, though it is thought that this can be overcome through the use of multi-frequency radioholography techniques. The relevant experimental confirmations employed microwave signal amplitude and phase meters, an Elektronika 100-25 computer and a microwave scanner with a receiving antenna scanned around a circle with a radius of 50 cm at a wavelength of 3 cm. Figures 5; references 7: 3 Russian, 4 Western (in Russian translation).

8225/5915
CSO: 1860/41

UDC 621.383.814

DIGITAL MODELING OF THE PROCESS OF NOISE FORMATION IN MULTISTAGE ELECTRON-OPTICAL TRANSDUCERS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 26 Feb 85) pp 13-17

[Article by M. G. Sosonkin]

[Abstract] The process of noise formation in electron-optical transducers is considered. A procedure is developed and a packet of applied programs is created for mathematical modeling with the aid of a computer of the statistical processes of multiplication in electron-optical transducers (EOT) of dark

pulses and photoelectrons. This makes it possible to obtain the distribution of the amplitudes of the brightness of pulses on the screen of a three-chambered EOT with magnetic focusing during various operational regimes. An evaluation is given of the reduction of the signal-to-noise ratio during amplification of a signal in the EOT. Figures 6; references 14: 10 Russian, 4 Western (1 in Russian translation).

6415/5915
CSO: 1860/83

UDC 681.3.04/05

CALCULATION OF SIGNAL-TO-NOISE RATIO IN PRECISION PHOTointegrator

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 6 Dec 85) pp 11-13

[Article by Ye. I. Chernov]

[Abstract] A photoreceiving device (PRD), analyzed by a number of authors in the past, includes a photoreceiver based on an operational amplifier (OA), at the input of which a photodiode is connected. Because the integrator in such a PRD operates with a broadband signal (photocurrent of the photodiode) high requirements are imposed on the OA response speed. The insufficient fast-response of the OA leads to dynamic errors of the PRD, which can be quite significant. The present article is concerned with a photointegrator free from these deficiencies. A simplified noise equivalent circuit of the photointegrator is presented. The values of the parameters are determined for which it is possible to consider the original precision photointegrator as a linear circuit. Expressions are obtained to determine the signal-to-noise ratio. Figures 1; references: 6 Russian.

6415/5915
CSO: 1860/83

UDC 535.345.6

OPTICAL FILTERS OF THREE SPECTRAL LINES BASED ON GYROTROPIC CRYSTALS WITH ISOTROPIC POINTS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 22 Oct 85) pp 4-6

[Article by L. M. Suslikov, Z. P. Gal'mash and V. Yu. Slivka]

[Abstract] Optical filters based on uniaxial gyrotropic crystals with isotropic points attract the attention of specialists by their high spectral parameters. Experimental investigations of the dependence of such filters on

the thickness of the crystalline elements indicates the possibility of broadening their functions--a transition from filtration of radiation with a wavelength λ_o of the "isotropic" points of the crystal to a selection of the radiation of two fixed wavelengths λ_1 and λ_2 arranged symmetrically on both sides of λ_o . The present article considers the possibility of constructing narrow-band selective optical filters, accomplishing the formation of three specified wavelengths determined beforehand, one of which λ_o matches. Figures 2; references 9: 6 Russian, 3 Western.

6415/5915
CSO: 1860/83

UDC 621.384.326.2

CALCULATION OF RADIANT EMITTANCE OF HEATED BODIES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 17 Feb 86) pp 6-8

[Article by Yu. A. Barbar and Ye. A. Vasilyev]

[Abstract] Radiant emittance calculations are necessary for the design of IR devices. Formulas are presented for automatic calculation of the values of integrated radiant emission in limited spectral ranges with the aid of programmable microcalculators which reduce calculation time by 1.5 - 2.5 orders as compared with the numerical integration method. They can be recommended for determining the values $M^0(0, \lambda, T)$ and $M^0(\lambda, \lambda_o, T)$ in the spectral range from 1 to 20 micrometers with temperatures from room to several thousands of degrees. Figures 1; references: 8 Russian.

6415/5915
CSO: 1860/83

UDC 531.71

EFFECT OF POLARIZED PROPERTIES OF ELEMENTS OF DOUBLE-BEAM INTERFEROMETERS ON BAND CONTRAST

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 18 Dec 85) pp 20-22

[Article by O. V. Lyubomudov]

[Abstract] The effect of the polarized properties of standard optical elements on the contrast of interference bands is investigated. The results and the method of this investigation can be used in the development and design of

interferometers, including the solution of problems of choosing the optimum properties of the elements and the arrangement of the circuits of interferometers under development. Figures 4; references 9: 7 Russian, 2 Western (1 in Russian translation).

6415/5915
CSO: 1860/83

UDC 681.7.055

PHOTOELECTRIC INTERFEROMETER FOR CHECKING THE SURFACE CONFIGURATION OF LARGE OPTICAL COMPONENTS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 18 Mar 86) pp 31-34

[Article by V. A. Gorshkov, O. N. Formin and S. N. Gorlov]

[Abstract] One of the common defects of the majority of known photoelectric interferometers (PEI) operating in real-time is the high sensitivity of interference patterns to vibration which reduces monitoring precision and limits the area of its application. The present article describes a PEI resistant to vibrations, intended for checking the surface configuration of optical components, and the results are presented of its experimental investigation under conditions of optical production. A block diagram and a photograph of the PEI are shown. Figures 2; references 7: 3 Russian, 4 Western.

6415/5915
CSO: 1860/83

UDC 681.785.3+666.1.053.512

METHODOLOGICAL ASPECTS OF ELLIPSOMETRIC EXPERIMENT ON OPTICAL MATERIALS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 23 Jan 86) pp 36-39

[Article by T. V. Andreyeva and V. A. Tolmachev]

[Abstract] The experimental possibility is shown of an evaluation of random errors in determining the parameters of the surface layers of specimens being investigated during an ellipsometric investigation of optical materials. The dependence is noted of $\delta\psi$ and $\delta\Delta$ of the angle of incidence and the way is shown to choose the optimum angle of incidence during investigation of various optical materials. It is shown that the method described for determining the precision of measurements is necessary for establishing an adequate model of effectiveness, since polygonal measurements are compared for certain determined

intervals of possible values of the magnitudes being determined. The question of measurement precision is most important when determining the spread of ellipsometric parameters of a polished surface. The examination presented of questions concerned with methods of conducting an ellipsometric experiment is useful for the study of film reflecting systems and nonoptic systems.

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CSO: 1860/83

UDC 621.373.826:621.396

OPTICAL COUPLER FOR FIBER-OPTICAL SYSTEMS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 23 Sep 85) pp 55-60

[Article by P. A. Demyanenko, V. D. Nazarov and A. G. Tereshchenko]

[Abstract] A survey is made of the contemporary state of work devoted to the development of optical couplers (OC) for fiber-optical systems. The basic types of OC are considered, and light is thrown on their design features and technological production, as well as their effect on the basic parameters of O.C. The following items are discussed in some detail: 1) Directional optical couplers based on fiber light guides; 2) Directional optical couplers based on discrete optical elements; and 3) Star-shaped optical couplers. Figures 28; references 42: 5 Russian, 37 Western.

6415/5915
CSO: 1860/83

UDC 621.383

DEVICE FOR MEASUREMENT OF LINEAR DISPLACEMENT OF SCANNING MIRROR OF FOURIER SPECTROMETER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 10, Oct 86
(manuscript received 25 Dec 85) p 61

[Article by V. I. Yerashov]

[Abstract] The principles of action are described of a device which makes it possible to measure displacement of the scanning mirror of a Fourier spectrometer, with an instability of speed not more than 10% with a precision of 1/16 the wavelength of the radiation of a laser, which for a Ge-Ne laser constitutes a magnetic equal to $3.95 \cdot 10^{-8}$ meter. The device is protected by the author with certificate number 1043490. Figures 1; references: 1 Western (in Russian translation).

6415/5915
CSOP 1860/83

UDC 53.089.6:621.37.089.5:621.373.826

UNIT FOR CHECKING MEANS OF MEASURING THE AVERAGE POWER OF LASER RADIATION

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 25-26

[Article by S. A. Kaufman, A. P. Knyupfer and A. A. Liberman]

[Abstract] The device for checking means of measuring average power (MMAP) described in this article is intended for transfer of the size of units of the average power of laser radiation from a master means of measurement (MMM) to an operating means of measurement in accordance with the requirements of GOST 8.2F5-78. The MMAP operates on a 10.6 micrometer radiation wavelength. Power of the MMM is conducted at power levels of 80-100 watt. The basic relative error of MMAP does not exceed $3 \cdot 10^{-2}$. A block diagram of the MMAP is presented and the following items are included in its description: 1) Error of MMM; 2) Error of diffraction divider; and 3) Error caused by instability of the power of laser radiation. Figures 1; references 3: 2 Russian, 1 Western.

6415/5915
CSO: 1860/77

UDC 389.14.535.373.3.08:681.7.068.4

COMPLEX AND ELEMENT-BY-ELEMENT CERTIFYING OF MEANS OF MEASURING DAMPING IN FIBER-OPTIC LIGHT GUIDES

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 29-31

[Article by L. V. Nikolayev, M. P. Surodin and S. V. Tikhomirov]

[Abstract] This article considers in detail the prospective creation and use of standard fiber-optic attenuators for the measurement of damping, which requires development of equipment for measuring the damping in these attenuators with the necessary precision. Figures 1; references 9: 7 Russian, 2 Western (in Russian translation).

6415/5915
CSO: 1860/77

UDC 535.34.08:621.375.826.018.756

MEASURING DEVICE FOR DETERMINING ABSORPTION FACTOR DURING PULSE RADIATION

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 32-33

[Article by O. I. Yakovleva and A. A. Liberman]

[Abstract] During certification and investigation of high-precision means for measuring the energy of pulse laser radiation it is necessary to determine the absorption factor of the receiving element with an error not exceeding fractions of a percent. A device for solving this problem is described, which has a value of the total error of measuring the absorption factor of the receiving elements of $\alpha \leq 0.9$, with pulse radiation amounting to $\Delta a = 0.004$. Figures 1; references: 2 Russian.

6415/5915
CSO: 1860/77

UDC 681.7.022

MATHEMATICAL SOLUTION OF CERTAIN PROBLEMS OF ION BEAM SHAPING OF SURFACES

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 20 Jun 85) pp 1-4

[Article by V. G. Nazarov, V. K. Yefremov and I. K. Krasnov]

[Abstract] An axially symmetric ion beam with a diameter of $2R$ is used to machine flat surfaces, where the axes of surface and the beam are parallel and the process is controlled by controlling the time that various points on the surface are exposed to the ion beam. The rate of surface material removal is constant. This paper analyzes the applicability of various numerical methods to the solution of such shaping problems, deriving analytical expressions as a function of the initial parameters and an optimality criterion: 1) The case of axially symmetric shaping when D_s is less than $2R$ (D_s is the diameter of the shaped surface; 2) When D_s is more than $2R$ and 3) Axially asymmetric machining when D_s is more than $2R$. It is noted that the use of the algorithm described here has demonstrated its usefulness in producing technically feasible solutions with acceptable computing times and errors of less than 10% of the surface machining precision tolerance in addition to optimizing a number of uncontrolled parameters in the computations, e.g. the distribution of the ion beam intensity in the working cross-section of the beam, the amount of displacement of the surface and beam axes or the step for the beam travel along the machining trajectory. Figures 4; references 6: 4 Russian, 2 Western (1 in Russian translation).

8225/5915
CSO: 1860/43

UDC 535.231.6

COMPARISON OF VOLT-WATT SENSITIVITIES OF UNCOOLED THERMAL OPTICAL RADIATION DETECTORS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 26 Sep 85) pp 11-13

[Article by B. V. Vasilyev]

[Abstract] The considerable disparities in the internal resistance (from 10^{10} ohms at room temperature) of various types of thermal detectors of optical radiation makes it difficult to compare such devices in terms of the volt-watt sensitivity. This paper estimates this sensitivity for thermoelectric, pyroelectric, pneumatic and bolometric detectors, taking their internal resistance into account. The first three of these are devices that convert the radiant energy to heat and then to electrical energy; the best comparison is made in this case with an ideal thermal detector having the efficiency of an ideal heat engine using the Carnot cycle. Simple approximations for the volt-watt sensitivities of each of these devices and the sensitivity is plotted as a function of the load resistance, which ranges from 10^{10} to 10^{13} ohms. The temperature is taken as 293 K and the detector target area is 1 mm^2 . Sensitivity closest to that of an ideal detector is exhibited by a vacuum thermoelectric detector for the case of unmodulated flux. The worst sensitivity is shown by a pyroelectric detector with a triglycine sulfate target 10 micrometers thick. Figures 4; references 3: 2 Russian, 1 Western (in Russian translation).

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UDC 535.317

CALCULATING PARAMETER TOLERANCES FOR OPTICAL SYSTEMS

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 5 Oct 85) pp 19-21

[Article by V. M. Chirkov, S. V. Pozdnov and Yu. I. Sverchkov]

[Abstract] Computer-aided design and manufacturing of complex optical systems require the determination of the tolerances allowed in their fabrication and assembly. This paper proposes a general scheme for computing parameter tolerances taking their process limits into account. The scheme considers all of the aberrations as well as the labor requirements; the problem of tolerance computation is formulated as a parameter optimization problem with constraints, solved while taking into account a discrete set of possible tolerance values

for each structural parameter. Stochastic optimization is employed in the scheme to define the tolerances with due consideration of the economic factor. The general analytical approach is applied to the design of the Mir-56A miniature photographic objective lens assembly ($f' = 50$ mm at 1:2.8). A detailed analysis is made of the contributions of the various parameter errors to the overall required tolerances. In the sample case above, the index of refraction of the fourth lens makes the greatest contribution to the minimum tolerance. The proposed method clearly reflects the contribution of each fabrication error to the total scattering of the lens systems and can be used for quantitative estimates of the possible tolerance extensions. Tables 2; references: 7 Russian.

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UDC 535.824.4

OPTICAL BEAM SPLITTER AND SWITCHER FOR LINEARLY POLARIZED LIGHT

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 1 Dec 85) pp 25-28

[Article by V. I. Dolotko, V. I. Krichevskiy, V. F. Martynov and
A. P. Kharchenko]

[Abstract] A beam splitter with a variable division ratio has been designed and tested. It is capable of splitting a linearly polarized laser beam into a specified number of elementary rays and spatially switching any two adjacent rays at a rate of from a few Hz to several GHz. The operating principle of the device is based on birefringence of the linearly polarized light in a uniaxial crystal. A wedge prism cut so that the optical axis of the crystal is oriented along the small leg of the triangle and the wedge is mounted at an angle to the propagation path of a broad light beam. Each ray of the diverging beam in the main section within the crystal is split into ordinary and extraordinary rays with mutually orthogonal polarization. These rays exit the crystal with some phase difference that is a function of the refracting layer in the crystal and the transverse polarizations of these rays are different: elliptical, circular or linear. If a polaroid analyzer is inserted in the light path, it brings the ordinary and extraordinary rays into the same plane and they are coherent, traveling in the same direction with some phase difference. The resulting interference patterns from the two monochromatic waves that are out of phase mutually complement each other, i.e. the light bands are switched to two positions. A schematic of the splitting and switching device using the above effects is drawn: the system uses a laser, electro-optical crystal, cylindrical lens, wedge prism, polaroid analyzer and a screen. Experimental tests demonstrated that a beam could be split into 2 to 30 smaller beams with a quartz wedge having a long side of 20 mm. The electro-optical crystal of the commercial ML-201 modulator switched adjacent channels at a rate of up to 1 GHz. Figures 4; references 7: 4 Russian, 3 Western (2 in Russian translation).

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CSO: 1860/43

UDC 621.396.6:621.383(03)

OPTRONIC TRANSDUCER FOR SMALL DISPLACEMENTS WITH COAXIAL ARRANGEMENT OF LIGHT SOURCE AND PHOTODETECTOR

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 16 Jan 86) pp 32-33

[Article by I. G. Chizh, G. P. Komarov, I. V. Kravchenko and I. I. Katsan]

[Abstract] An unpackaged GaAs AL-109A light emitting diode is used as the light source in a movement sensing device. The photodetector is fabricated from a KDB-7.5 silicon wafer. A 0.8 mm diameter hole is drilled in the center portion of the Si chip by a laser and a lightguide is positioned in this hole; this removes the LED from the p-n junction of the photodetector so as to eliminate internal background illumination of the sensitive region of the detector and produces the requisite characteristic curve for the light radiation in the space between the optical sensor and the surface being monitored in addition to reducing the impact of the LED temperature on the photosensitive diode. The optronic transducer has a sensitivity to longitudinal movements of a reflecting surface on the order of 0.4 micrometers and to transverse movements of about 0.1 micrometers. The vertical axis of symmetry of the sensor must be kept within $\pm 1.5^\circ$ of the normal to the monitored surface. The output voltage in mV is plotted as a function of the gap between the transducer and the reflecting surface; the maximum output voltage of 100 mW occurs with a gap of about 300 micrometers. Figures 2; references 6: 5 Russian, 1 Western.

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CSO: 1860/43

UDC 535.853:536.52

AUTOMATED DUAL CHANNEL SPECTRORADIOMETER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 25 Dec 85) pp 34-36

[Article by A. M. Biryukov, B. V. Vylegzhannin, A. M. Daushvili, D. S. Yermakov, D. G. Kuvalkin, I. N. Orlova, A. P. Sapelov, O. A. Snetkova, O. K. Taganov and A. S. Trufanov]

[Abstract] An existing dual channel spectroradiometer has been upgraded by modernizing the detecting and amplifying circuitry through the use of an Elektronika 60 microcomputer to automate the detection and data reduction. This paper details the new hardware and software developed for this system. Block diagrams show the spectroradiometer configuration and the interface with the computer. The maximum run time for any experiment is 10.0 s, corresponding to a maximum input data load of about 6 K with a memory requirement of 28 K. A Robotron printer is used for the data printout and the control programs are

fed in from punched tape. The signal recording precision is $\pm 0.5\%$ and signal amplitude measurement errors for the signals recorded by the light beam oscillograph on photographic paper are practically eliminated in this design. Figures 3; references 7: 6 Russian, 1 Western (in Russian translation).

8225/5915
CSO: 1860/43

UDC 620.192.47

STUDY OF POROSITY OF MATERIAL USING SCANNING ELECTRON MICROSCOPE

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 22 Nov 85) pp 43-45

[Article by M. D. Tolkachev and S. I. Kovbasa]

[Abstract] When analyzing the cleavage face of porous materials with a scanning electron microscope, considerable errors can arise because of so-called false pores formed on one side of the face when grains of the material from the other side are removed. This paper shows how such an error can be eliminated by using a matching-surface technique. The method essentially combines the images from the conjugate surfaces produced by the shearing of any sample, thus enabling the reconstruction of the nature of the material at the area of contact of the two single-grain layers and also makes it possible to ascertain and quantitatively estimate such parameters as the area of contact between the grains and the porosity. The application of the technique is illustrated with histograms showing the pore distribution in a sample according to size for pores from 55 to 120 micrometers before and after the matching-surface analysis. By combining the images, the number of small pores is shown to be two to three times more than the false indication of the earlier method and the pores from 110 to 220 micrometers completely disappeared, due to the overlapping of large pores by grains of the overlying single layer of the material. Figures 4; references: 5 Russian.

8225/5915
CSO: 1860/43

UDC 531.71

INFLUENCE OF POLARIZATION ON CONTRAST OF INTERFERENCE BANDS OF DUAL-BEAM INTERFEROMETER

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 11 Dec 85) pp 48-49

[Article by O. V. Lyubomudrov]

[Abstract] Since the contrast of the interference bands is a function of the light polarization in an interferometer, it is necessary to optimize the polarization parameters in order to improve the contrast. This paper is a mathematical analysis of the impact of polarization on interference band contrast, assuming that differences in the polarizations of the interfering rays are excluded by placing a linear polarizer at the interferometer output and also that the arms of the instrument are the equivalent of linear polarizers. Each of the arms is represented by a Jones matrix and expressions are found for the contrast and phase of the interference bands as a function of the polarization of the rays in a dual-beam interferometer. Best contrast is achieved in this case by using a polarized light source; when partially polarized light is used, the best contrast is had with partial linear polarization or when its maximum component is oriented in the direction for which the intensities of the interfering rays are the same. No numerical examples are cited. References 6: 2 Russian, 4 Western (3 in Russian translation).

8225/5915
CSO: 1860/43

UDC 681.7.02

EXPERIENCE WITH AUTOMATED POLISHING OF LARGE OPTICAL PARTS USING SMALL TOOL

Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 8, Aug 86
(manuscript received 6 Jan 86) pp 49-52

[Article by A. S. Savelyev and A. P. Bogdanov]

[Abstract] A computer-aided machine tool system based on the AD-700 polishing machine can finish rigidly mounted optics up to 700 mm in diameter using a small tool by regulating the time that the tool stays at the surface points being machined through the use of numerical control. This paper describes the operation of the system in polishing a 412 mm diameter mirror (focal distance of 1,129.9 mm) made of SO 115m Sitall. The mean square deviation of the mirror surface from the closest sphere was 1/2 wavelength for a wavelength of 0.6328 micrometers; the astigmatism was initially 1/2 wavelength. The automated polishing required 14 hours and the final mean square deviation was brought down to 1/35 wavelength and the maximum deviation from the closest sphere did not exceed 0.1 wavelength with a residual astigmatism of 0.027 wavelengths.

The use of interference patterns to generate a topographical map of the surface relief is described in some detail along with the operating parameters of the polishing tool. Figures 3; references 5: 4 Russian, 1 Western.

8225/5915
CSO: 1860/43

UDC 671.7.068.089.5:535.32

MEASUREMENT OF DISPERSION CHARACTERISTICS OF FIBER LIGHT GUIDES

Moscow IZMERITELNAYA TEKHNIKA in Russian No 6, Jun 86 pp 25-30

[Article by S.V. Tikhomirov and T.N. Khleskova]

[Abstract] Literature data on mechanisms that cause dispersion in multimode fiber light guides [VS] and methods for evaluating quality of VS were analyzed. Forms of presentation and specific features of and methods for measurements of time and frequency properties of optical fibers were examined. The effect of instrumentation was analyzed. From the standpoint of automation of the measurement process and application of minicomputers and microprocessors for processing measurement results, the most convenient method is the method of pulse measurements in the time region with subsequent transition into the frequency region. Its hardware realization is rather simple, whereas the cost of equipment is relatively low. As optical fibers manufacturing technique improves and pulse response duration decreases, additional difficulties in formation, detection and processing of subnanosecond optical signals develop. Results, obtained by others in comparing various measurement methods or establishing relations between these methods, were described. A conclusion was made that pulse and direct methods of measurement for obtaining information on frequency characteristics of VS are equivalent in principle, although each method has its advantages and drawbacks, as far as their practical realization is concerned. A drawback of the modulation method is the difficulty of performing an unambiguous and accurate measurement of the phase-frequency characteristic of VS.

References 33: 10 Russian, 23 Western.

12770/5915
CSO: 1860/283

VIDEO FREQUENCY ACOUSTICAL-OPTICAL CORRELATOR WITH TIME INTEGRATION

Moscow RADIOTEKHNIKA in Russian No 11, Nov 86
(manuscript received after revision 13 May 86) pp 36-39

[Article by V. V. Vasilyev, K. R. Naumov, and V. N. Ushakov]

[Abstract] The article calculated the signal-to-noise ratio at the output of an acoustical-optical correlator with time integration (AOCTI) intended for processing of video signals and characterized by an increased interval of the acceptable comparative delay of the input and reference signals. The characteristics are listed of a laboratory mock-up used in an experimental test of the AOCTI, and the satisfactory results of the test are presented. Figures 2; references 6: 4 Russian, 2 Western.

6415/5915
CSO: 1860/80

UDC 621.315.592

INFLUENCE OF ION IMPLANTATION AND LASER ANNEALING ON DEFECT EVOLUTION IN SILICON

Moscow MIKROELEKTRONIKA in Russian Vol 15, No 6, Nov-Dec 86
(manuscript received 19 Dec 85) pp 528-531

[Article by V. P. Kalinushkin, A. A. Manenkov, G. N. Mikhaylova, M. G. Ploppa, A. M. Prokhorov, A. S. Seferov, Yu. N. Chekhonadskiy and I. B. Khaybullin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] The impact of the implantation of P^+ ions and the subsequent nano-second laser annealing on the evolution of the defects in dislocation free silicon in which aggregations of electrically active impurities were detected beforehand is ascertained by studying the light scattered from the material at different wavelengths. Two lasers (a CO_2 laser at 10.6 micrometers and a CO

laser at 5.5 micrometers) are used as the test sources for the small angle scattering study that reveals the size of the scattering defects and their concentration by analyzing the scatter patterns. The discussion of the preparation of the silicon samples (having nonimplanted, implanted and annealed areas) is followed by analyses of the scattered light intensity as a function of the scattering angle. Inhomogeneities on the order of 7 micrometers found in implanted and annealed boron doped silicon, just as in the case of phosphorus doping, are aggregations of free carriers. The mechanism increases the scattered light intensity in nonimplanted and unannealed regions of the semiconductor. The authors are grateful to professor F. A. Semiletov and his associates for the electron diffraction studies. Figures 4; references 13: 9 Russian, 4 Western (1 in Russian translation).

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POLARIZATION PROCESSES IN PYROLYtic LAYERS OF PHOSPHOROSILICATE GLASS

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(manuscript received 5 May 85) pp 542-547

[Article by Ye. G. Salman, V. N. Vertoprakhov, P. G. Dukhanova, L. N. Mazalov and S. D. Erenburg, Institute of Inorganic Chemistry, Siberian Department, USSR Academy of Sciences]

[Abstract] Layers of phosphorosilicate glass (PPS) are produced by pyrolysis of a mixture of trimethylphosphate or phosphine with monosilane and oxygen at 720 K on substrates of KEF-4.5 silicon. The P_2O_5 concentration in the films ranged up to 15% by weight; the thickness was 0.8 to 0.9 micrometers. The thin PPS layers were annealed in Ar for 30 minutes at 750 to 1,320 K and Al contacts were applied. This paper studies the influence of phosphorus doping and annealing conditions on the electrical relaxation processes in the PPS layers. The process of low temperature polarization of PPS layers is independent of the fabrication method, being governed only by the fundamental properties of the material. Increasing the phosphorus concentration suppresses the ion drift but increases the instability due to the polarization processes. The existence of these two opposing processes is responsible for an optimal P_2O_5 content of such glasses (4 to 8% by weight). Annealing of the glass reconfigures their structure, ordering the glass and is accompanied by a redistribution of trapped Na ions between the matrix of the layer and the phosphorus atoms, resulting in more complete bonding of these ions. The increased polarizability of PPS glass due to the annealing is because of the increase in the number P = O bonds due to the removal of bound water. An anomalous current peak occurring during the first heating of unannealed samples is due to the desorption of polymolecularly adsorbed water. The restructuring of the PPS layer during annealing prevents moisture penetration into the film and increases its electrical stability. Figures 5; references 19: 10 Russian, 9 Western.

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SPEED OF STORAGE MEDIUM BASED ON MAGNETORHEOLOGICAL SUSPENSION FOR INFORMATION VISUALIZATION AND STORAGE

Moscow MIKROELEKTRONIKA in Russian Vol 15, No 6, Nov-Dec 86
(manuscript received 8 Apr 86) pp 560-562

[Article by M. N. Levin, Ya. A. Monosov and V. A. Shakhunov, Institute of Radio Engineering and Electronics, USSR Academy of Sciences]

[Abstract] The storage medium using a magnetorheological suspension proposed in USSR Patent No 717706 is employed for the visualization and storage of infrared radiation with high spatial resolution. This paper analyzes the speed of

this medium for such applications. The speed is uniquely related to the structural formation time for the dispersed magnetic phase when the suspension is exposed to the IR radiation being registered as well as permanent or pulsed magnetic fields. The IR heat causes a phase transition in the binder, changing its thermal and magnetic rheological properties, while the external magnetic fields magnetize the particles of the dispersed phase, producing gradients in the internal magnetic fields of the suspension, resulting in a structural change. Oscilloscope traces showing the change in the optical transmittance of the suspension and the magnetic field as a function of time indicate that the response time of such a medium is from 0.2 to 0.4 ms. The minimum time of 0.2 ms obtained experimentally corresponds to an increase in the optical transmittance of the medium of 100 times. It is also shown in this experimental study that the structural formation process takes place in three stages: 1) The delay of the onset of the change in the optical transparency relative to the point in time of exposure to the magnetic field; 2) The process of increasing the medium transparency, and 3) Saturation. Figures 4; references 4: 3 Russian, 1 Western.

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PHASE CONJUGATION OF SOUND BEAMS IN ALTERNATING MAGNETIC FIELD

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 17 Feb 86) pp 658-661

[Article by A. P. Brysev and V. N. Streltsov, Institute of General Physics,
USSR Academy of Sciences]

[Abstract] Phase conjugation with simultaneous amplification of the sound waves is possible by means of uniform time modulation of the sound velocity. Since it is difficult to achieve high modulation levels in this case, a better possibility is preliminary phase conjugation of the sound beam (without amplification) and then amplifying it by traditional methods. This paper shows the feasibility of sound wave phase conjugation in plasma-like media by means of helicon-phonon interaction in an external alternating magnetic field and the direct interaction of this field with the ion component. The case of interaction in a solid plasma is of the most practical significance and it is assumed in this paper that the helicon-phonon interaction occurs via the piezo-electric effect. The physical picture is simple: sound wave propagation in the device produces a transverse, piezo-induced electric field. The combined effect of this field and the external magnetic field on the conductivity electrons results in a time-modulated electric current, which because of the inverse piezoelectric effect, leads to effective parametric interaction of the forward and return waves. Numerical estimates for LiF show that the effective interaction length corresponding to 50% conversion of the incident wave amplitude to the reflected component is about 5 cm. The requisite alternative magnetic field intensity is about 200 Oe. Direct interaction of an ionic sound wave with an alternating magnetic field is an adequate mechanism for sound wave phase conjugation; in contrast to helicon-phonon interaction, this mechanism is realized in any ionic crystal. References 2: 1 Russian, 1 Western.

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TWO-PHONON ACOUSTIC SELF-INDUCED TRANSPARENCY IN SOLID PARAMAGNETIC MATERIALS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 25 Nov 85) pp 661-664

[Article by L. L. Buishvili, N. P. Giorgadze and M. G. Menabde, Institute of Physics, Georgian SSR Academy of Sciences]

[Abstract] Acoustic self-induced transparency with acoustic magnetic resonance occurs in a dilute solid paramagnetic material under conditions of two-phonon resonant absorption. Assuming the effective spin of the paramagnetic center is 1 and that quadrupole splitting occurs, this paper derives expressions for the steady-state waveform of the pulse propagating through a sample as well as the group velocity. A convenient material is MgO doped with Fe²⁺, since the spin-phonon coupling is quite high for these ions, because of which, the two quantum resonance line width is about 10 Hz, while the single quantum width is about 400 Hz. It should thus be anticipated that longer acoustic pulses can be used to study two-phonon acoustic self-induced transparency than in the single phonon case. The authors are grateful to A. R. Kessel for his interest in the work and useful discussions. References 8: 5 Russian, 3 Western.

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ANISOTROPY OF BULK ACOUSTIC WAVE VELOCITY CONTROL USING ELECTRIC FIELD IN PIEZOELECTRIC MATERIALS HAVING SILENITE STRUCTURE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 4 Jun 85) pp 664-666

[Article by S. I. Burkov, M. P. Zaytseva, Yu. I. Kokorin, B. V. Sobolev, B. P. Sorokin and N. A. Chetvergov, Institute of Physics imeni L. V. Kirenskiy, Siberian Department, USSR Academy of Sciences]

[Abstract] The anisotropic influence of a DC electric field on changes in the velocities of bulk acoustic waves in piezoelectric materials having a silenite structure is numerically simulated, based on data obtained earlier on the nonlinear electromechanical properties of such crystals. The velocities of the waves are plotted as a function of the angle relative to the major crystal axes for all modes propagating in the given direction in the deformed state. The relevant parameters of delay lines and phase shifters controlled by an electric field and based on Bi₁₂GeO₂₀ and Bi₁₂SiO₂₀ are summarized in a table. The best control is achieved for quasilongitudinal and quasishift fast modes in directions close to the [110] and [210] axes, respectively. The anisotropy of the nonlinear properties of the material becomes especially important in this case.

A lithium niobate surface acoustic wave device controlled by an electric field is shown to have inferior control parameters and it is also noted that the effect of the change in the phase shift with exposure to the electric field increases in proportion to the frequency of the acoustic wave, because of which, the controlling field will be significantly smaller at higher frequencies. Figures 2; references: 2 Russian.

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MULTICHANNEL COHERENT EFFECTS DURING SOUND BACKSCATTERING IN CLOSED VOLUMES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 29 Jul 85) pp 666-667

[Article by O. Ya. Butkovskiy, Yu. A. Kravtsov and V. V. Ryabykin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Multiple coherent effects can be observed in closed volumes where re-reflections from the walls and corners produce a field backscattered to the source. Such effects essentially consist in the fact that each double, triple (or higher) scattering channel has a coherent channel that is the inverse of it (in the sense of the sequence of diffraction and reflection events). The fields corresponding to these channels are the same by virtue of the reciprocity theorem. This paper describes the specific features of the manifestation of coherent effects in such enclosed spaces. These effects can be used to estimate the quality of anechoic chambers and tanks by means of the adduced formulas. No sample calculations or designs are cited. References: 5 Russian.

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SOUND WAVE PROPAGATION CLOSE TO AXIS OF REFRACTION WAVEGUIDE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 2 Jan 86) pp 667-670

[Article by N. A. Veshev, Leningrad Institute of Aviation Instrument Making]

[Abstract] A point source positioned close to the axis of a slightly irregular refraction waveguide generates an acoustic field. While the portion of the field corresponding to remote rays is readily calculated, the field close to the waveguide centerline cannot be found through conventional ray geometric

analysis. This paper applies dual-scale expansions in a system of ray coordinates tied to the axis (rather than cartesian) as to derive analytical expressions for calculating waveguide propagation modes as a function of distance. The proposed computer algorithm converges rapidly, since it employs explicit formulas for solving the Sturm-Liouville problem (the calculation of about 30 modes takes a few seconds on an M-4030 computer). The author is grateful to S. Yu. Slavyanov for discussing the work. Figures 1; references: 3 Russian.

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CONTACTLESS METHOD OF STUDYING ACOUSTIC FIELDS OF FOCUSING ULTRASONIC TRANSDUCERS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 28 Oct 85) pp 670-675

[Article by L. R. Gavrilov, V. N. Dmitriyev and L. V. Solontsova, Acoustics Institute imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] An ultrasonic acoustic field is produced by a focused transducer in a medium where the use of physical probes is precluded (e.g. as for sonograms in medical applications). Previous field measurement techniques using inserted needles with miniature detectors moved relative to the source provide limited data; this paper proposes a contactless method of measuring the amplitude and phase distribution of such ultrasonic fields by exploiting the directional properties of focusing transducers used as detectors. The local field region where the measurements are made must coincide with the center of curvature of the detector. By moving the detector relative to the source, the spatial distribution of the sound pressure can be measured. The relevant analytical expressions are derived and the amplitude and phase distribution of the sound pressure is plotted in the focal plane of a focusing radiator ($R = 70$ mm) using a frequency of 0.96 MHz in water. Another experimental check of the theory shows the sound pressure amplitude distribution in the focal plane of a radiator ($R = 60$ mm) operating at 0.228 MHz in water and air as measured with the focused detector. It is shown that the method can determine the spectral composition of cavitation noise in the local field region. Focused detectors can be used as well in medical applications, because of their high sensitivity and the elimination of invasive probes. The authors are grateful to B. S. Surikov for his useful discussion of the work and the results. Figures 6; references 9: 7 Russian, 2 Western (1 in Russian translation).

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POWER ENGINEERING PARAMETERS OF RESONANT HYDRAULIC SOUND RADIATORS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 7 Apr 86) pp 683-685

[Article by V. I. Zagan]

[Abstract] A water-powered acoustic radiator is represented by a simple equivalent electrical circuit (valid for output frequencies of about 10 Hz and up): a hydraulic power source driving a series network consisting of the hydraulic resistance of the radiator piping, the hydraulic resistance of the hydraulic amplifier and the internal hydraulic resistance of the radiator plus the radiation resistance. Two operating modes are analyzed: continuous, when a pumping station with a constant output is used as the hydraulic energy source; and pulsed, when the power source is a hydraulic power storage system, charged up to the working pressure in the pauses between output pulses. The acoustic power and hydraulic acoustic efficiency of the radiator are functions of the radiation resistance and the internal hydraulic resistance of the radiator. The maximum acoustic power corresponds to the maximum efficiency in the case of CW operation; in the pulsed mode, because of the nonlinearity of the hydraulic resistance, the maximum emitted power corresponds to the case when the radiation resistance is double the internal hydraulic resistance and the efficiency is then 67%. Simple analytical expressions are derived for the radiator Q and efficiency as well as the relevant resistances in these two modes. No numerical or design examples are given. Figures 2; references: 2 Russian.

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SELF-INDUCED LIGHT DIFFRACTION BY SURFACE ACOUSTIC WAVES

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 32, No 5, Sep-Oct 86
(manuscript received 3 Mar 86) pp 694-695

[Article by A. I. Kozlov, V. P. Plesskiy, Institute of Radio Engineering and Electronics, USSR Academy of Sciences]

[Abstract] Laser excitation of a sound conducting surface can produce Rayleigh surface acoustic waves. The SAW velocity can be precisely measured in a contactless way using the laser excitation of the waves and a laser probe for detecting them. These two functions can now be accomplished with a single laser beam by registering the SAW diffraction of the beam generating the waves. Pulse or amplitude modulation of the beam intensity is used in this case and this paper demonstrates that the same effect can be observed in CW operation with the frequency shift of one of the laser beams. This method requires less laser power than before. A simple formula is given for the diffracted beam

intensity and numerical estimates are made for aluminum, showing the feasibility of the technique. The authors are grateful to S. N. Antonov and V. I. Grigoryevskiy for their useful discussion of the problem. Figures 1; references 5: 2 Russian, 3 Western.

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ACOUSTICAL WAVE AND ELECTRON INTERACTION IN SEMICONDUCTOR WITH REGULARLY SPACED CONTACTS IN ALTERNATING ELECTRIC FIELD

Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 31, No 9, Sep 86
(manuscript received 28 Feb 84) pp 1832-1838

[Article by Yu. V. Gulyayev, G. D. Mansfeld and S. V. Boritko]

[Abstract] Acoustic waves are induced in a structure consisting of periodically alternating piezoelectric semiconductor layers between and under electrical contacts. The ohmic contacts are connected in such a way that the DC and AC electric fields oppose each other in adjacent semiconductor gaps. During acoustic wave propagation, the piezoelectric fields accompanying the waves and the acoustoelectric field create a current through a load resistance in an external circuit. This current has both AC and DC components. The flow of the electrons in the transverse electric drift field excites stimulated electron waves in the semiconductor, resulting in a number of interesting features of the acoustic wave and electron interaction: frequency conversion and multiplication, as well as synchronous signal detection. The use of such periodic arrays of ohmic contacts makes it possible to directly observe electron waves excited with the simultaneous exposure of the piezoelectric field to the acoustic wave and alternating drift field. Analytical formulas are derived that describe electron absorption and the acoustic wave velocity in the alternating field, taking the phase of the field into account. Expressions are also found for the acoustoelectric current through the load. The authors are grateful to A. G. Kozorezov for the useful discussion of the results. Figures 2; references: 10 Russian.

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COMPENSATION OF EFFECT OF FLUCTUATIONS OF SOUND VELOCITY IN FREQUENCY
ULTRASONIC FLOWMETERS

Moscow IZMERITELNAYA TEKHNIKA in Russian No 11, Nov 86 pp 40-41

[Article by A. G. Ovchinnikov]

[Abstract] A method is presented for optimization and selection of the parameters of the measuring circuits of ultrasonic flowmeters which make it possible to decrease the effect of fluctuations of the sound velocity in a controlled medium. Figures 1; references: 5 Russian.

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